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Cost Estimating Guide for Performing Economic Analyses in the Military Construction, Army (MCA) Process

by
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An economic analysis (E/A) is required for most projects proposed for the Military Construction Army (MCA) program. The E/A helps determine which alternative for a project is cost effective, and which alternative would obligate the Army to the lowest overall life-cycle cost. Computer programs are available to automate the actual preparation of the analysis and report but they cannot actually gather and apply cost data; this must be done by an analyst, and it is usually the most difficult and time-consuming aspect of the E/A.

This report provides useful information for both the inexperienced and the experienced analyst. It provides an overview of cost estimating in the MCA process, a definition of terms and basic principles, methods of computing and documenting costs, and sources for specific cost data. Also included are sample worksheets to help the analyst organize data for input to the Economic Analysis Package (ECONPACK) computer program, and several examples of E/A reports generated by ECONPACK.

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COST ESTIMATING GUIDE FOR PERFORMING ECONOMIC ANALYSES IN THE MILITARY CONSTRUCTION, ARMY (MCA) PROCESS

1 INTRODUCTION

Background

As part of the Military Construction, Army (MCA) program, an economic analysis (E/A) must be performed and revised during different phases of a construction project. The most difficult aspects of performing E/As are determining which costs apply to alternatives identified in the E/A and what dollar amount should be estimated for each applicable cost. Once these cost estimates are obtained the E/A can be performed with relative ease using a computer program. ECONPACK and PC ECONPACK,* computer programs developed by the U.S. Army Corps of Engineers, are available for use by Army and other Department of Defense (DOD) analysts to perform economic analyses in support of funding requests. These analyses are used to compare the life-cycle costs of various alternatives that meet an Army requirement. All costs associated with each alternative must be estimated and input to computer files to produce an E/A that ranks the alternatives in order of economic preferability.

Purpose

The purpose of this report is to explain and clarify for the military construction analyst the process of cost estimating for the E/As required for MCA and related programs. Cost data sources, methods of computation, and cost documentation are the focus of this report.

Approach

This report documents cost data sources most often used in an MCA economic analysis. It takes the reader quickly through the MCA cycle, focusing on the Guidance Year of that cycle. From there, the most commonly considered project alternatives are defined, and associated groupings of costs (or "Cost Kinds") are given. A comprehensive listing of costs within each Cost Kind (and their sources) is given. Finally, four documented economic analyses are presented as examples. In the appendices are presented methods for calculating certain costs, an example of a fully documented economic analysis, various indices that should be used in certain situations, and a brief listing of some commercially available cost data sources.

Scope

This report is not intended to provide guidance for developing cost estimates at the "board and nail" level, but rather to help the analyst define which costs should be included in an analysis and possible data sources for estimating these costs. For example, it should be sufficient for the analyst to know that cost estimates for specific utilities (e.g., water, sewer, electricity) are needed for a building, and that the

*ECONPACK is Economic Analysis Package; PC ECONPACK is the same program designed for personal computers.

building is a general administrative type with 22,000 sq ft† housing 240 personnel. From this information, the Directorate of Engineering and Housing (DEH) utilities office or a utilities company can estimate yearly utility costs. The analyst is normally not expected to know the relationships needed or tables existing to find this data. In another example, estimating the construction cost of a new barracks, preliminary estimates can be developed knowing the number of personnel to be housed and/or how many square feet are needed in the building. Construction cost data can then be obtained from various sources (DD Form 1391 Processor, DEH Engineer Plans and Services Division, the supporting Corps Division or District Office, etc.).

†1 sq ft = 0.093 m^2

2 AN OVERVIEW OF COST ESTIMATING IN THE MCA PROGRAMMING PROCESS

Timing of an Economic Analysis

With few exceptions, a basic requirement for an economic analysis exists for all projects proposed for inclusion in the MCA and related programs. An E/A is conducted and documented according to Army Regulation (AR) 11-18,[1] Office of Management and Budget (OMB) Circular A-104,[2] and AR 415-15.[3] An economic analysis is included in a project's documentation as Special Requirements Paragraph 1 (SRP-1) of DD Form 1391.

An economic analysis is normally conducted in two parts: a basic and an update. The basic analysis is completed before the submission date of the full DD Form 1391 package (during the last 3 months of the project's Guidance Year). Although the basic analysis may be conducted at any time before submitting the full DD Form 1391 package, the best time is early in the Guidance Year. At that time, the nature, scope, and cost estimate of the project have become better defined, and there is still enough time to complete the analysis and document the results before the required date of submission. The analysis is updated immediately after completing concept design to determine if the project is still economically justified. Note: after this update, further revision of the E/A may be necessary as the scope or other major project criteria change, or as a consequence of higher level review comments about the accuracy and adequacy of the E/A. If there has been at least one major change to the project (such as the availability of an alternative that was not previously available or a major change in the estimated cost of a project), an updated analysis should be performed. If the results of the updated analysis show that an alternative other than the proposed project is the most economical, a report of the findings should be promptly sent to the appropriate level of commands. In any event, submission must be no later than the date of submission of supplemental data to Congress. Figure 1 shows the major events of the MCA Cycle. It is Time Phase A, the Guidance Year of the MCA Cycle, that is relevant to the use of this cost guide in performing initial E/As.

Life-Cycle Cost Analysis

Economic analyses can help the decisionmaker effectively allocate resources only when all direct and indirect resource implications associated with each alternative are considered. The E/A must analyze the impact of all costs incurred during the life span of the alternative. This is important because a comparison of initial investment costs alone can be misleading. For example, renovation may require less of an initial capital investment, but its annual operations cost and major repair costs may be much higher than similar costs for other alternatives. Thus, costs throughout the entire period of the analysis must be identified in order to accurately assess the total cost of ownership over the life span of an asset. These costs are compared using the time value of money (discounting) concept. This process is known as life-cycle cost analysis.

ECONPACK, a computer program developed by the U.S. Army Corps of Engineers, performs standardized life-cycle cost calculations: net present values, equivalent uniform annual costs, savings-to-

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[1] Army Regulation (AR) 11-18, *The Cost and Economic Analysis Program* (Headquarters, Department of the Army [HQDA], 7 May 1990).

[2] OMB Circular A-104, *Evaluating Leases of Capital Assets* (1 June 1986).

[3] AR 415-15, *Military Construction, Army (MCA) Program Development* (HQDA, 1 December 1983).

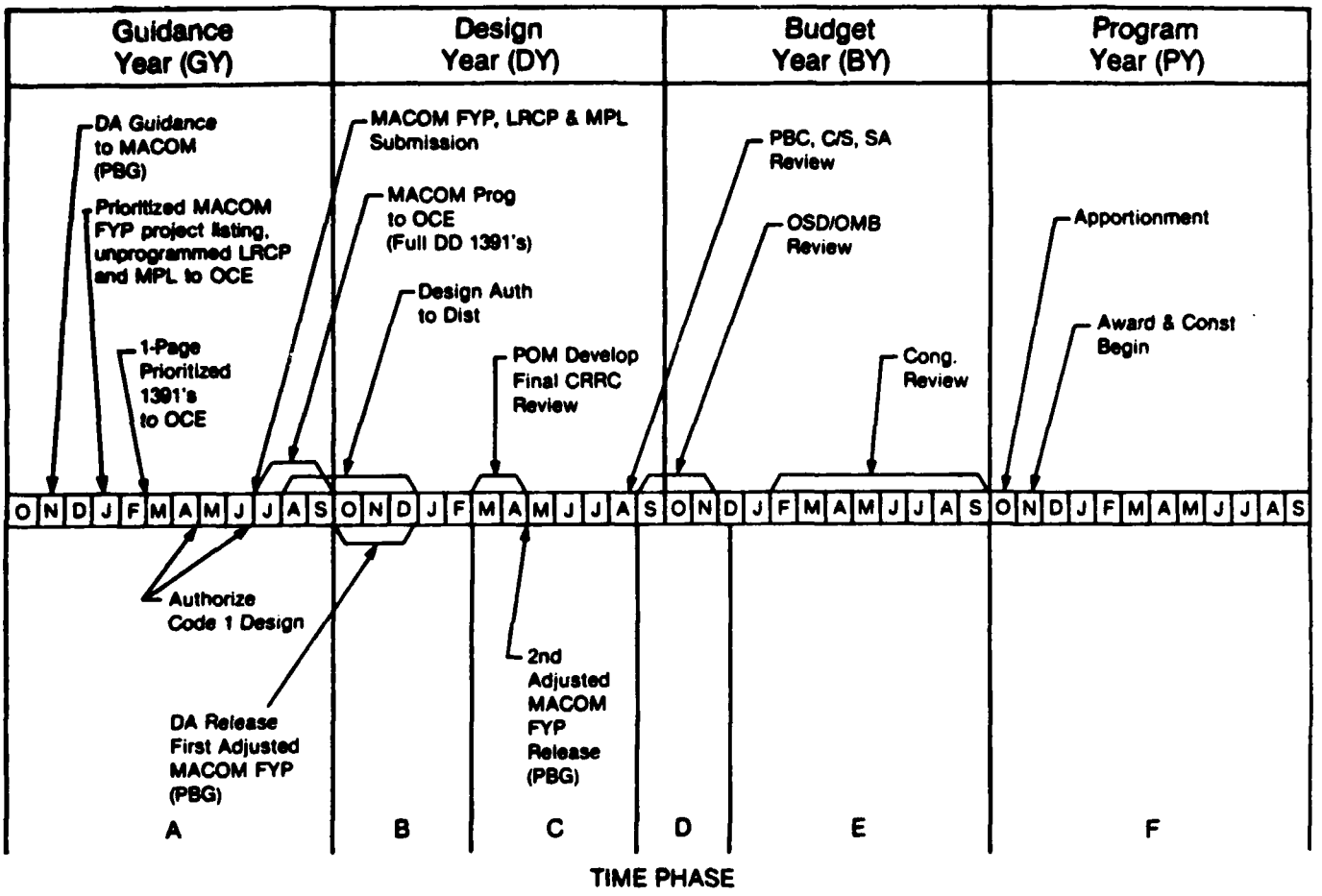

Figure 1. Major events in the MCA cycle. (Abbreviations are defined in the List of Acronyms at the end of this report.)

investment ratios, and discounted payback periods. A sensitivity analysis feature and graphics capability are included in the ECONPACK program. Text entry is permitted for assumptions, alternative definitions, source and derivation of costs, results, and recommendations.

Overall Cost Estimating Process

Estimating costs for a project generally occurs after all feasible alternatives have been identified. In most military construction project alternatives, there are two basic phases for which costs must be estimated: the facility acquisition phase and the ownership phase.

Developing cost estimates for the E/A is most often done by someone on the master planning staff. This person must determine the kinds of costs involved in each alternative, and this usually involves a search for appropriate unit costs (per square foot for similar facilities, per labor-hour rates, per kilowatt-hour, etc.). The analyst must use a variety of sources (e.g., manuals, historical records, organizations, experts) to get data as detailed in Chapter 4. When all of the appropriate unit costs have been determined,

annual costs to be included in the E/A are calculated. They are usually expressed as unit costs multiplied by the number of units. Finally, life-cycle cost adjustments, such as those due to location, inflation, building age, depreciation, appreciation, and discount rate, are applied either off-line (using adjustment factor tables) or on-line (using ECONPACK).

Producing Auditable Results

As a general rule, the best way to guarantee auditability in an economic analysis is to document it accurately and include the documentation as part of the E/A text. With regard to cost estimates, this amounts to clearly documenting the data sources, computational formulas, and adjustment factors used in developing the estimates. ECONPACK facilitates this recordkeeping through its text entry capability and report format. Some general guidelines for producing an auditable E/A include the following:

- The cost estimating methods used must be obvious or clearly explained. They must be appropriate and include no illogical steps.

- All relevant and significant costs must be included.

- Sunk costs—those occurring before the analysis period—must be properly excluded.

- Sources of the cost data must be provided and they must be applicable.

- All cost estimates must be made in the proper type of dollars: base-year constant (noninflated) dollars for a normal analysis and current-year (inflated) dollars for an analysis with a lease alternative.

- All relevant and appropriate adjustment factors must be considered: inflation, building age multipliers, geographic, site appreciation, building obsolescence, etc.

- If the Status Quo is an alternative, it must be documented clearly and comprehensively so differences between it and other alternatives are obvious.

Expense Items

"Expense Item" is the term used in ECONPACK for the separate cost items for each project alternative. These are entered as dollar amounts for each year of the period of analysis. There should be as many expense items entered into the E/A as there are differential costs associated with an alternative. (In an E/A only costs that differ among alternatives are considered in the analysis.) "Life-cycle cost" implies comparison of all differential costs associated with alternatives over time and according to the time value of money. However, there is no hard and fast rule on how to define each expense item in an E/A. For example, the expense item "utilities" may be entered in place of the four expense items "water, gas, sewer, and electricity," and the annual cost would reflect the sum of the four individual utility costs. However, the definition of "utilities" and the calculations and source for the costs must be documented.

When documenting expense items used in an E/A, the analyst must be clear about what is and is not included. If the analysis shows utilities as an expense item, all specific components of the item (e.g., water, sewer, gas, electricity) must be documented.

3 PROJECT ALTERNATIVES, COST KINDS, AND COST ESTIMATING METHODS

Economic Analysis Alternatives

Possible alternatives have been grouped into nine types listed below, which represent the most typical alternatives considered for military construction E/As. These may be defined and tailored according to specific needs. The documentation prepared should indicate how each alternative evaluated was defined to meet a specific requirement.

Status Quo

The status quo alternative assumes that existing facilities will continue to be used to meet the requirement and that routine maintenance will continue to be performed. In a primary E/A, the Status Quo constitutes the baseline against which all other alternatives are evaluated. The alternatives considered for meeting a deficiency will be evaluated based upon how much better (dollar savings) they are than the current (status quo) situation. In a secondary E/A, when there is a new mission requirement, the status quo is not a feasible alternative if it cannot meet the new mission. Nevertheless, the costs of current operations may need to be included in the economic analysis to account for costs incurred before an alternative begins meeting the requirement (e.g., status quo costs incurred during construction of a new facility).

Renovation

This alternative involves a change to the interior or exterior of a facility to improve its current use. This can include installed equipment that is made a part of the existing facility.

Conversion to New Use

Conversion involves a change to the interior or exterior of a facility so it may be used for a new purpose. This can include installed equipment that is made a part of the existing facility.

Addition

This alternative involves a change to a real property facility that adds to its overall external dimensions. Other terms synonymous with addition include "expansion" and "extension."

New Construction

A new construction project is considered a single undertaking to produce a complete and usable facility. It includes all construction work, land acquisition, supervision, inspection and overhead costs, and procurement and installation of specific types of built-in equipment necessary to make a facility complete and usable.

Commercially Financed Facilities (Third-Party Financing)

Commercially Financed Facilities (CFF) is an alternative method of providing facilities and services that uses the private sector as the primary source for financing. The CFF concept is relatively straightforward: the Government enters into a long-term contract or lease for the provision of a facility or service

for which the Army is the principal customer. Ultimately, the Army seeks to obtain a package of services from the private sector at a lower cost than through the traditional MCA acquisition process. The package of services usually includes the financing, design, construction, and operation and maintenance of the facility over a 20- to 32-year period. The facilities generally do not belong to the Government at the end of the contract term. CFF offers opportunities for the Army to acquire needed facilities that would not successfully compete in the traditional financing arenas due to budgetary restrictions and higher priority Army requirements.

When leasing facilities is an alternative in an economic analysis, certain aspects of the analysis and costs involved are different from those of a traditional economic analysis. OMB Circular A-104, *Evaluating Leases of Capital Assets*, contains mandatory procedures for evaluating leasing as an alternative to new construction (by the Government) on-post (also see Appendix A). These procedures, among other things, stipulate the use of different discount rates in calculating life-cycle costs. The purpose of a lease-versus-buy analysis is to determine whether it would cost less to lease or to construct and buy an asset. It should be noted that cost elements that apply to commercially financed facilities constructed on-post may differ from those that apply to commercially financed facilities off-post. Some of these differences are indicated in Chapter 4.

Other Existing and Available Government Facilities

This alternative involves the use of existing and available facilities to satisfy a need. They can be DOD facilities or non-DOD facilities. Examples include the use of a training range at a nearby installation as an alternative to building a new range, or the use of other Government office space as an alternative to constructing an administrative building.

Contract for Services

This alternative involves the provision of a service by a source other than the Government. It often involves housing, especially the provision of transient quarters and unaccompanied personnel housing (UPH), but it can include the provision of a wide range of other services, such as wastewater treatment by the local Government facility, manufacturing, maintenance, or distribution facilities, or use of a local airport runway.

Combination of Alternatives

It may be possible to consider combinations of alternatives listed above. For example, in an analysis to eliminate a UPH deficit of 200 personnel (PN), several feasible alternatives might include:

- Renovation of existing barracks space for 100 PN plus new construction on-post for 100 PN
- New construction on-post for 100 PN plus leasing of 100 units off-post
- New construction on-post of space for 200 PN.

In this case, costs associated with the renovation, new construction, and off-post leasing would need to be identified.

Alternatives and Applicable Cost Kinds

A Cost Kind is a group of costs (expense items) composed of related cost elements. The following are definitions of the most commonly used Cost Kinds:

Initial Investment

These costs are those initially incurred for an alternative. For construction of a new facility or renovation/conversion/addition, these include design, construction contract, supervision and inspection of the construction contract, any research and development costs, site preparation, information systems, and support facilities as defined in AR 415-15. If an alternative involves new construction, costs are usually available from Programming, Administration, and Execution (PAX) system newsletters or from a commercial source such as Means or Dodge (Appendix B). If an alternative involves renovation or conversion, the cost of removing old subsystems (such as heating and plumbing) needs to be included.

Personnel

These are costs for military or civilian personnel who will be employed in the operation or management of a function. For production-type facilities this can be a crucial part of the economic analysis, as different alternatives may allow different production line designs that require different numbers of personnel. These costs can also include the occupants' transportation time in going from one facility to another. Personnel costs should always be fully burdened, i.e., they should include salary, benefits, and overhead.

Administrative

This Cost Kind involves the management of the facility. It occurs frequently in the housing area where housing managers and assistants are required to manage housing units. It does not include the normal costs to occupants in the management of their space.

Facility Maintenance

This Cost Kind contains the annual type of maintenance costs such as those normally done with service orders. It also includes ongoing maintenance such as that done with standing operations orders and any scheduled activities such as the biannual inspection of a facility. Preventive maintenance is also included. Any maintenance costs not considered a major repair or replacement also fall into this category. Maintenance requirements vary according to a number of factors, including building age, type, and geographical location. Annual maintenance does not include the replacement of major building systems, such as the roof, floor, or heating, ventilating and air conditioning (HVAC) equipment.

Utilities

This Cost Kind includes all utilities consumed, whether provided by the Government or by contract. Costs are for gas, electricity (both purchased and generated), oil, wood, coal, water, and sewer. It does not include construction or maintenance costs for utilities plants or distribution lines. Unit costs for the various sources of energy are usually converted to a cost per British thermal unit (Btu). Conversion factors are available from the DEH energy office. Sample inflation and escalation indices for energy costs can be found in Appendix C.

Services

Included in this Cost Kind are miscellaneous engineer services such as trash hauling, snow removal, insect control, grounds maintenance, and security. Many unit costs (dollar per ton for trash hauling, dollar per acre for grounds maintenance, dollar per square foot for insect control, etc.) can be obtained from the annual facility engineer's summary of operations (Technical Data Report or Red Book).

Periodic Repair/Replacement

These costs are major one-time or periodic costs occurring during the life of the project. Examples are replacement of a roof, overhaul or repair of an air conditioning system, remodeling the kitchen of a house, and rewiring a building. For any alternative lasting 20 years or more, several of these should be considered. Periodic repair/replacement costs are a function of the lifetime of each building subsystem and the cost for the subsystem's replacement. The lifetime of each subsystem depends on a variety of factors, including construction type (e.g., concrete or wood exterior walls, pitched or built-up roof, etc.) level of regular maintenance, and climatic conditions.

Allowances

Included in this Cost Kind are allowances for quarters, such as Basic Allowance for Quarters (BAQ) and Variable Housing Allowance (VHA). Family Separation Allowances and Temporary Living Allowance (TLA) (after permanent change-of-station [PCS] moves) are other elements of this Cost Kind.

Furnishings

This is the cost of furnishing a facility. For housing it includes furnishings themselves and their replacement, maintenance, repair, storage, distribution, security, and all other property management functions. For non-housing it may include office furniture if the cost varies between alternatives. Otherwise it is a wash cost* and need not be included in the analysis.

Equipment

This Cost Kind is a very broad category and can vary from a refrigerator in a house to a heavy crane in a maintenance shop. It includes kitchen equipment in a dining hall, refrigeration equipment in a hospital, a boiler in a heat-generating plant, a gas line, and an electrical power line. This is frequently a wash cost because all alternatives will generally use the same equipment.

Salvage/Demolition

This Cost Kind can be either a positive or negative cost. If the facility has a salvage or residual value at the end of the analysis period, then that value represents a benefit (an inflow of funds) to the Government. On the other hand, if a facility must be removed or demolished, there will be a cost to the Government. Appendix D provides information about calculating salvage value in a lease-versus-buy analysis.

*A cost that is the same in all the compared alternatives.

Travel/Transportation/Moving

One type of cost in this category is the transportation of personnel using a facility. An example would be if one project alternative involved using a training facility at another installation and trainees would have to be transported (versus construction of a new training facility on-post). Another example would be the contract cost to obtain moving service for permanent relocation to another usable facility.

Land

Both land purchases and costs of easement are included in this category. In certain lease analysis situations the imputed cost of land owned by the Government must be estimated.

Insurance

This is the cost of insuring a privately held asset. The Government is self-insured so insurance costs are considered only when leasing is one of the alternatives. Estimates of imputed insurance are based on insurance premiums for comparable private assets.

Lease

This is the annual charge to the Government for leasing a facility or asset in the private sector.

Real Estate Taxes

These are included in certain types of lease analyses and are imputed for the Government. Estimates of these taxes are based on taxes on comparable private property.

Communications (Information Systems)

This Cost Kind includes items such as telephone, telegraph, and other types of communications equipment.

Security

This Cost Kind includes expenses involved in providing security service for a facility.

Parking

This includes the cost of parking vehicles at a facility. An example of this Cost Kind being involved in an alternative would be the leasing of a facility and its parking spaces off-post.

Inherited Assets

In some cases, an alternative will employ an existing asset (e.g., equipment, facility, etc.) that would otherwise be used in another project. In this case, its value at the base year of the analysis would be a cost and must be included in the analysis since the asset could serve another purpose. On the other hand, if an asset associated with an alternative will be sold or made available for some other use, its value would be subtracted from the cost of the alternative.

Toxic Substance Removal

This Cost Kind includes the cost of removal of toxic substances, such as hazardous waste cleanup at a construction site or removal of asbestos from a building prior to demolition.

Figure 2 shows the most commonly used Cost Kinds for the alternatives previously discussed.

Cost Estimating Methods

Perhaps the most difficult phase of an E/A is the estimation of costs. However, this part of the E/A is crucial because the analysis will be defensible only to the extent that the cost estimates are reliable. Estimates can never be 100 percent precise because they are made several years before the costs will actually occur. This implies that inflation will have an impact, but inflation rates vary over time and location. Standards such as the level of maintenance for a facility also may vary in the future, which can change the maintenance cost of the facility. Estimates must be as precise as possible given the constraints on the analyst in performing the E/A. Precision is usually obtained by acquiring as much detailed data as possible. The three primary methods of cost estimation are described below.

Analogy Method

This is the most widely used method. Historical costs are obtained for a similar facility. In some cases, the analyst must make judgments when using this method. These judgments must be documented properly in the E/A report. The analogy method is used often in estimating facility acquisition or renovation costs. Historical construction costs for similar facilities on the installation or in neighboring communities can be used. Estimates of annual recurring costs are often obtained by this method when the analyst can obtain current, accurate records of costs such as roofing repairs, custodial service, and energy consumption for similar types of facilities. Application of these cost records requires expert judgment and experience by the analyst and the DEH staff.

Industrial Engineering Method

In this method, estimates from various separate segments of the project are combined into a total project estimate. It is commonly used in projects involving production-type situations such as maintenance shops and ammunition production facilities. However, the principles of this method can be used for any type of analysis. The analyst must have extensive knowledge of the system, operating processes, and organization. The system is divided into its components and estimates for each component are made. This breakdown allows the analyst to determine which costs are known and, thus, where effort must be directed to obtain estimates. This process allows an emphasis on estimating costs for which little information is available. In some cases, industrial engineering techniques such as work measurement or time-and-motion studies may be needed to make the estimates. In other cases, the analogy method may be used for each component of the system. Once the costs have been estimated for each component, they are combined to obtain the estimate for the whole system. Because this method is so detailed, it can be very costly to execute.

ALTERNATIVE / COST KIND	STATUS QUO	RENOVATION	CONVERSION	ADDITION	NEW CONSTRUCTION ON POST	CFF	OTHER GOVERNMENT FACILITIES	CONTRACT FOR SERVICES
INITIAL INVESTMENT		X	X	X	X		X	
PERSONNEL	X	X	X	X	X	X	X	X
ADMINISTRATIVE	X	X	X	X	X	X	X	X
FACILITY MAINTENANCE	X	X	X	X	X	X	X	X
UTILITIES	X	X	X	X	X	X	X	X
SERVICES	X	X	X	X	X	X	X	X
PERIODIC REPAIR/REPLACEMENT	X	X	X	X	X	X	X	X
ALLOWANCES	X	X	X	X	X	X	X	X
FURNISHINGS	X	X	X	X	X	X	X	X
EQUIPMENT	X	X	X	X	X	X	X	X
SALVAGE/DEMOLITION	X	X	X	X	X	X		
TRAVEL/TRANSPORTATION/MOVING	X	X	X	X	X	X	X	X
LAND (ACTUAL OR IMPUTED)	L	L	L	L	L	L	L	L
INSURANCE (ACTUAL OR IMPUTED)	L	L	L	L	X		L	L
LEASE	L	L	L	L	L	L	L	L
TAXES (ACTUAL OR IMPUTED)	L	L	L	L	L	L	L	L
COMMUNICATIONS (*Information Systems*)	X	X	X	X	X	X	X	X
SECURITY	X	X	X	X	X	X	X	X
PARKING						X	X	X
INHERITED ASSETS		X	X	X	X			
TOXIC SUBSTANCE REMOVAL	X	X	X	X	X			

X = Cost Kind may be applicable for E/As performed under AR 11-18 guidance.
L = Cost Kind may be applicable for E/As performed under OMB Circular A-104 guidance when lease is an alternative.

Figure 2. Cost Kinds most commonly associated with various construction alternatives.

Parametric Method

In this method, the total cost of an alternative or some part thereof is estimated on the basis of specified physical and performance properties and their relationships to component costs. In other words, a functional relationship is established between the cost (total or partial) of an alternative and the various properties of its parameters. "Parameter" is defined as a cost-related explanatory attribute that may assume various values during actual calculations. A parametric estimate depends directly on the ability of the analyst to set up relationships between the attributes that comprise the alternative. The analyst must select and describe the cost-influencing factors of the alternative. For example, the construction of family housing involves (among others) the number of stories, the number of dwelling units in the building, the number of bedrooms, baths, dens, and recreation rooms, the floor area of the various rooms, garage size, and lot size. If house prices are known for various combinations of these parameters, prices for other parameter mixes may be estimated relative to this baseline. Ease of estimation and accuracy of estimates increase with the increase in number of actual combinations for which prices are known. Given many combinations, the analyst can develop a valid cost estimation relationship. Statistical techniques such as regression analysis can be used to develop equations that describe such relationships.

4 THE PROCESS OF COST ESTIMATING

Cost Data Sources

Table 1 on the following pages provides the analyst with a comprehensive listing of costs within each of the Cost Kinds listed above, along with possible data sources. As a rule of thumb, the analyst should obtain cost estimates from the DEH or DEH-related sources whenever possible. Doing this accomplishes two things:

- It provides the analyst with historical, site-specific, actual-cost data, eliminating most of the uncertainty in applying geographic adjustment factors in the analysis.

- For initial investment costs, it provides the analyst with construction cost data for assets that were built according to Government specifications.

Whenever appropriate site-specific DEH data are not available, the analyst should use Government sources whenever possible. This could include cost data obtained from on-post organizations such as the Directorate of Logistics (DOL), the Directorate of Contracting (DOC), or the Directorate of Resource Management (DRM); or more global data sources such as the PAX Newsletters, General Services Administration (GSA) Furnishings Catalogs, and GSA Government Fleet Data. Of course, exceptions to this rule exist, especially with the Commercially Financed Facilities alternative. In this case it is often necessary to estimate costs from the developer's point of view. For initial investment costs, commercial cost sources such as those published by R.S. Means and Dodge Cost Systems may be more appropriate (Appendix B). In addition, costs associated with the purchase of land, insurance, and property taxes may not be available from Federal Government sources, so it may be necessary to contact local Government offices, insurance agencies, or real estate agencies.

Sample Economic Analyses

On the following pages are four examples of developing costs for E/As that were used in actual PC ECONPACK inputs (Figures 3-6). They include analyses that address the requirements for an administration building, a barracks with a dining facility, a vehicle maintenance shop, and a family housing complex. In these examples, most of the output from PC ECONPACK has been suppressed so emphasis can be placed upon the source and derivation of costs. For an example of the output for a fully documented PC ECONPACK E/A, refer to Appendix E.

It should be emphasized that the costs in each E/A are the specific estimates of one individual analyst. Another analyst could very well estimate them differently, resulting in somewhat different values for the estimates. Thus, it is critical that sources and derivations be well documented so reviewers can determine the applicability of the analyst's sources and methods to the specific E/A. In a third party contract alternative, for example, the analyst could use either Means or Dodge to estimate the construction cost and would get slightly different answers from each. Cost estimating is not an exact science and need not be for purposes of E/As.

Table 1

Cost Kinds, Associated Costs, and Data Sources

COST KIND	ASSOCIATED COSTS	DATA SOURCES	REMARKS
Initial Invesument	New Construction Costs	PAX Newsletters; Tri-Service Housing Cost Model; R.S. Means Building Construction Cost Data; Dodge Heavy Construction Cost Data; Valuation Quarterly.	Use PAX Newsletters for Construction On-Post. Otherwise, use Means or Dodge. Valuation Quarterly for current market value.
	Renovation/Conversion/Addition	ERMD - Similar Projects Dodge - Remodeling and Retrofit Cost Data; Means - Repair and Remodeling Cost Data	DOD limit is currently $20 per square foot.
Personnel	Military Personnel Civilian Personnel	DRM, TAG Component, Military Pay Office, TRADOC-FORSCOM Resources Factor Handbook, SIDPERS	Use fully loaded labor rates. DRM for historical costs.
	Contract Personnel	DOC	
Adminstrative	Housing Manager, Contract Manager, Admin Assistant, Training	DEH Admin Office, CPO, DRM, DOC	
Facility Maintenance	Annual PM	IFS (System Maintainer), IFS R&D Report, Tech Data Report ("Red Book"), BMAR Report, DD 1391 Prep Course Materials Table 2, USACERL Life-Cycle Data Base	ERMD is responsible for maintaining IFS and for developing locally unique reports. EP&S may have data, e.g., painting contract costs.
		Life-Cycle Cost Analysis: A Guide for Architects	Published by AIA.
Utilities	Historical Consumption	DEH Tech Data Report ETL 1110-3-309 Local Utility Company	
	Projected Fuel Prices	Local Utility Company, Dept of Energy	
Services	Engineer Services (Snow Removal, Custodial, Refuse Collection, Entomology)		
	Performed In-House	DEH Tech Data Report	
	Performed by Contract	DEH, DOC	

Table 1 (Cont'd)

COST KIND	ASSOCIATED COSTS	DATA SOURCES	REMARKS
Periodic Repair/Replacement	Facility Components (HVAC Equipment: See Equipment, Fixed Industrial, below)	DEH Planner/Estimator, DEH Contracting Office, CERL Life-Cycle Data, R.S. Means, Dodge	
Allowances	VHA, BAQ, OHA, TLA	DRM, TRADOC, FORSCOM Resources Factor Handbook, SIDPERS	
Furnishings	Household	GSA, DOC, DOL, Housing Office, R.S. Means	
	Office	GSA, DOC, DOL Property Book, R.S. Means	
Equipment	Acquisition		
	Non-Tactical	DEH (Roads & RR Br), Sweets Catalog	
	Tactical	DOL, TMP	
	Production	DEH, Sweets Catalog, GSA, DOC, DOL	
	Fixed Industrial	DEH, Sweets Catalog, GSA, DOC	
	ADPE	Tenant ISC Activity, GSA, DOIM	
	Operation & Maintenance		
	Non-Tactical	DEH (Roads & RR Br), DOL, GSA Federal Fleet Data Reports	
	Tactical	DOL, TMP	
	Production	DEH, DOC, DOL	
	Fixed Industrial	DEH	
	ADPE	Tenant ISC Activity, DOC	
	Disposal	Defense Reutilization Office	
	Expected Useful Life	OMB Circ A-76	
Salvage/Demolition	Salvage Value		
	Building Decay Factors	OMB Circ A-104	
	Site Appreciation Factors	OMB Circ A-104	
	Methodology for Estimating Equipment Estimates	Appendix D of this Guide OMB Circ A-76	
	Demolition	DEH - Similar Projects, DOC, Dodge - Remodeling and Retrofit Cost Data	

Table 1 (Cont'd)

COST KIND	ASSOCIATED COSTS	DATA SOURCES	REMARKS
Travel/Transportation/Moving	Location-to-Location Same Site	DOC, DRM	DOC, if previously done by contract. DRM, otherwise. G6 to determine training requirements.
	Troop Movement	TMP, DOC, G6	
	Permanent Change of Station	JTR	
	Per Diem Rates	JTR	
	Movement of Passengers	TRADOC-FORSCOM Resources	
	Movement of Freight	Factor Handbook	
Land	Land Value	Corps District Office Real Estate Office Local Assessor, Local Realtors	
Insurance	Liability During Construction	Corps District Office BOMA Experience Exchange Commercial Insurance Firms	
	Insurance After Occupancy	BOMA Experience Exchange Commercial Insurance Firms	
Lease	Annual Lease Payment	Corps District Office Real Estate Office, GSA	
	Methodology for Calculating	Appendix C of this Guide	
Taxes	Developer Tax	Local Assessor Corps District Office Real Estate Office	
	Property Tax	Local Assessor Corps District Office Real Estate Office	
Communications	Outside 5-Foot Line	Tenant ISC Activity	
Security	Provision of Security Services	Provost Marshal	
	Security Structures (e.g., fences)	DEH Estimating Branch	
	Other Security Costs	Corps Omaha District Office	
	Rules for Clearance for COMSEC Equipment	Local Intelligence office NSA DOD Industrial Security Manual 5220.22-M	

Table 1 (Cont'd)

COST KIND	ASSOCIATED COSTS	DATA SOURCES	REMARKS
Parking	Parking Cost	Corps District Office Real Estate Office, GSA	
Inherited Assets	Current Value (Residual Value)	Corps District Office Real Estate Office, GSA, Appendix D of this guide	
Toxic Substance Removal	Asbestos Removal Asbestos Disposal Other Toxic Substances	DEH - Similar Projects DEH Environmental Office OCE Environmental Office EPA Environmental Office	

EXECUTIVE SUMMARY REPORT

PROJECT TITLE: Battalion Command and Control Center
PROJECT OBJECTIVE: Provide 30,000 sq ft of Administrative Space
DISCOUNT RATE: 10.00%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR: 1989
BASE YEAR: 1989

ASSUMPTIONS OF THE ANALYSIS:

1. The existing battalion assignments and TOEs will remain at their recently (FY 86) increased levels.

2. The overall installation requirements for battalion administrative area will not diminish to the point of equaling the adequate space available in the real property inventory.

3. The market value of existing temporary mobilization and World War II facilities is near zero and it is cost prohibitive to renovate them to meet the objective.

4. Utilities and access are readily available to the proposed construction sites.

5. Construction will be completed in one year with occupancy occurring the following year.

6. All three feasible alternatives will provide the minimum required administrative space.

7. Existing facilities on post have been fully programmed so that no conversion of existing facilities or diversion of other planned construction can occur without creating an adverse economic impact.

8. Existing and available off-post facilities would have to be located within a 2-mile radius to maintain the existing readiness posture of the battalions.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:

1. New Construction. Construction of a new, 30,000 Square Feet battalion command and control center is the most attractive option since the proposed site is near the existing cantonment area and would provide the most cohesive and consistent functional opersation of the battalions in modern facilities.

2. Additions to Existing Administrative Facilities. This alternative would provide 15,000 Square Feet of building additions to the existing 15,000 Square Feet of battalion administrative facilities within the current divisional area of the cantonment. Expanding the existing Command and Control buildings would provide the necessary areas and allow the installation to maintain its proposed stationing plan.

3. Lease Existing and Available Off-Post Facilities. This alternative would involve the relocation of current battalion command and administrative functions to a site within a reasonable distance of the battalions' cantonment areas.

Figure 3. ECONPACK E/A for an administration building.

ALTERNATIVES COMPARED:

ALTERNATIVE	NPV	EUAC
1 New Construction	$2,491,030	$271,918
2 Additions	$1,535,169	$167,577
3 Lease	$2,539,412	$277,199

RESULTS AND RECOMMENDATIONS:

Alternative 2, Additions to Existing Administrative Facilities, would provide the required administrative space at least-cost. Therefore, it should be pursued.

ACTION OFFICER: John Doe
ORGANIZATION: Fort Knox, Engineer Plans and Services Division

SOURCE AND DERIVATION OF COSTS AND BENEFITS: Costs for the three alternative were derived as follows:

1. New Construction.

a. Initial Investment. Construction is estimated to be $68/Square Foot. This figure was taken from PAX Newsletter 19. Construction should be completed during the base year. Total construction costs for the new facility are

$68/Square Foot X 30,000 Square Feet = $2,040,000.

b. Annual Maintenance Costs. Annual costs for this type of facility were taken from R.S. Means Square Foot Costs Data 1987. It is estimated to be $.48/Square Foot. Using OMB/OSD inflation indices to bring this cosst to FY 89 costs yields

$.48/SF X $(1.032)^2$ X 30,000 SF = $15,336.

c. Utilities. Annual utilities costs were developed from the 1987 DEH Tech Data Report using OMB/OSD inflation rates as follows:

FY 87 Cost per SF = $.54/SF.
FY 89 Cost = $.54/SF X $(1.032)^2$ X 30,000 SF = $17,253.

d. Periodic Roof Replacement. Roof replacement is estimated to occur in year 16 of the facility life (15-year life for a roof was taken from BOMA Experience Exchange 1987.) A cost of $4.60/SF was taken from R.S. Means Building Construction Cost Data 1986 and inflated to FY 89 to yeild

$4.60/SF X $(1.032)^3$ X 30,000 SF = $151,676.

Figure 3. (Cont'd).

e. Custodial. An FY 87 cost of $.41/SF was obtained from the Directorate of Contracting (DOC) based upon an existing contract for similar facilities. This cost was inflated to FY 89 to yield

$.41/SF X $(1.032)^2$ X 30,000 SF = $ 13,100.

2. Additions to Existing Facilities.

a. Initial Investment. A similar addition was completed in FY 87 at a cost of $62/SF. This cost was inflated to FY 89 and applied to the 15,000 SF of additional space to yield

$62/SF X $(1.032)^2$ X 15,000 SF = $ 990,472.

b. Annual Maintenance. FY 89 costs for the existing 15,000 SF of space were developed from the FY 87 DEH Tech Data Report by applying OMB/OSD inflation:

FY 87 Cost = $ .58/SF
FY 89 Cost = $ .58/SF X $(1.032)^2$ X 15,000 = $ 9266.

Annual maintenance costs for the additional 15,000 SF are estimated to be the same as the New Construction annual costs:

$.48/SF X $(1.032)^2$ X 15,000 SF = $ 7668.

Therefore, the total annual maintenance requirements for FY 1990 through FY 2016 are

FY 1989 Costs + FY 1990 Costs = $ 9266 + $ 7668 = $ 16,934.

c. Utilities. Same cost per SF as New Construction:

FY 89 Cost = $.54/SF X $(1.032)^2$ X 15,000 SF = $ 8627.

d. Periodic Roof Replacement Roofs on the existing facilities are 9 years old. So in years 6 and 21 of the analysis they will be replaced. The roofs on the additions will be replaced during year 16. Cost per SF is the same as Alternative 1:

$4.60/SF X $(1.032)^3$ X 15,000 SF = $ 75,838.

e. Custodial. Same cost per SF as Alternative 1:

$.41/SF X $(1.032)^2$ X 15,000 SF = $ 6550.

3. Lease Existing and Available Facilities Off-Post. Personnel in the Real Estate Division of the Corps of Engineers Louisville District Office were contacted to determine the availability of off-post facilities. 30,000 SF of administrative space is available within a mile of Fort Knox at a cost of $.70/SF/Month. The lease includes the cost of rent, utilities, annual maintenance, custodial, and major repairs and

$.70/SF/Month X 12 Months X 30,000 SF = $ 252,000.

Figure 3. (Cont'd).

EXECUTIVE SUMMARY REPORT

PROJECT TITLE: Barracks with Dining Facility
PROJECT OBJECTIVE: Provide Barracks Space for 592 Additional Personnel
DISCOUNT RATE: 10.00%
PERIOD OF ANALYSIS: 27 YEARS
START YEAR: 1986
BASE YEAR: 1986

ASSUMPTIONS OF THE ANALYSIS:

Background. Fort Lewis is located on the southern end of Puget Sound in the State of Washington. The installation occupies land in both Pierce and Thurston Counties. Fort Lewis is the home of the I Corps.

The existing adequate permanent barracks available comprise 11,206 enlisted personnel spaces. There are 12,444 spaces in substandard temporary barracks that cannot be made adequate due to cost limitation. These are open bay, gang-style latrine, wooden structures at North Fort Lewis. The units of the 9th Infantry Division and artillery units organic to the Division have been housed in existing permanent barracks on the east side of Gray Field (Troop Areas 1-6) and will continue to be located in these facilities. Other units which are not organic to the Division but which, by virtue of their missions, have similar training requirements are also housed in these barracks predicted upon their being within walking distance of rifle and mortar firing ranges and other facilities.

The new facilities which are the subject of this economic analysis are necessary due to the activation of the 29th Signal Battalion and HHC, I Corps. The data contained in the Unaccompanied Personnel Housing (UPH) Survey, DD Form 1657, dated 1984, demonstrate the current UPH deficit. The requirement is to house 592 additional personnel equivalent to 170,150 square feet.

Assumptions. The following assumptions are made:

1. The activation of the new units referenced above will be permanent and not result in the reduction of other units on the post.

2. No adequate permanent facilities are available to serve the new units.

3. Semi-Permanent structures do not comply with privacy and permanent facility criteria specified in DOD Manual 4270.1.

4. Utilities are available within a reasonable distance to support the new facility.

5. Construction of the new facility will take 2 years.

6. The cost of renovating existing temporary mobilization barracks exceeds statutory cost limitations.

Figure 4. ECONPACK E/A for a barracks with dining facility.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS: The following alternatives were considered:

1. Construct New Permanent Facilities.
2. Construct Semi-Permanent Facilities.
3. Contract Out Basic Allowance for Quarters (BAQ) and Separate Rations (SR).
4. Renovate Temporary Facilities to minimum acceptable standards.
5. Continue with the Use of Temporary Facilities.

Because alternatives 4. and 5. do not meet the criteria for providing permanent type facilities, only alternatives 1. through 3. will be considered in this analysis.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC
1 New Construction	$22,670,566	$2,454,262
2 Semi-Permanent Const	$25,756,795	$2,788,369
3 Contract BAQ and SR	$25,160,918	$2,723,861

RESULTS AND RECOMMENDATIONS: Since Alternative 1, New Construction, provides the highest standard of living at the least-cost, it is the alternative that should be pursued.

ACTION OFFICER: John Doe
ORGANIZATION : Fort Lewis, WA

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

1. Calculation of Basic Allowance for Quarters (BAQ) and Separate Rations (SR). The following calculations update the analysis that was originally done in FY 1983. Allowance rates were obtained from the Military Pay Office at Fort Lewis. Authorized spaces in the new units include 544 personnel in the E3 - E4 pay grade range, 40 in the E5 - E6 range, and 8 in the E7 - E9 range. Average allowance rates were used for each range. Growth indices were taken from AR 415-17.

FY83 Monthly Allowances

Grade	Contract BAQ		Separate Rations		Number of Personnel		Monthly Total
E3	$147.00		$140.40				
E4	$164.40		$140.40				
Average	$155.70	+	$140.40	x	544	=	$161,100 (rounded)
E5	$186.60		$140.40				
E6	$194.10		$140.40				
Average	$190.35	+	$140.40	x	40	=	$ 13,200
E7	$213.60		$140.40				
E8	$249.60		$140.40				
E9	$272.40		$140.40				
Average	$245.20	+	$140.40	x	8	=	$ 3,100

Figure 4. (Cont'd).

Total FY83 Monthly Allowance: $177,400

Total FY83 Annual Allowance: $2,128,800

Growth Adjustment Factors From AR 415-17:
FY86: 1619
FY83: 1324

Growth Adjustment Ratio	**X**	**Total FY83 Allowance**	=	**FY86 Costs**
1619/1324	**X**	**$21,128,000**	=	**$2,597,100.**

2. Investment Costs.

a. Permanent Facilities. $18,589,000 from EIRS Bulletin.

b. Semi-Permanent Facilities. Similar facilities were constructed at Fort Hood, T in January 1978 at a cost of $210,000 per 4,032 Square Feet, or $52.08 per Square Foot (SF). The following AR 415-17 adjustment factors were used:

Location Adjustment from FY 78 to FY 86: 1.15/.98 = 1.17
Cost Growth from FY 78 to FY 86: 1619/764 = 2.12

Therefore, FY 86 Costs = 1.17 X 2.12 X $52.08/SF X 170,150 SF = $21,980,000.

3. Annual Maintenance Costs. All costs were taken from the FY 1981 Annual Summary of Operations (the Red Book) and inflated using AR 415-17 indices.

Facility	**FY81 Cost per 1000 SF**	**Number of SF**	**Growth Index Ratio (1619/1192)**	**Annual Maintenance**
Barracks	$620.47	124,640	1.35822	$105,038
Opns & Sup	$334.65	33,810	1.35822	$15,368
Dining	$620.47	11,700	1.35822	$9,861

These Annual Maintenance Costs are assumed to be the same for both Alternatives 1 and 2.

Figure 4. (Cont'd).

EXECUTIVE SUMMARY REPORT

PROJECT TITLE: Vehicle Maintenance Shop
PROJECT OBJECTIVE: Provide 131,702 Square Feet of Modern Maintenance Shops
DISCOUNT RATE: 10.00%
PERIOD OF ANALYSIS: 27 YEARS
START YEAR: 1990
BASE YEAR: 1990

ASSUMPTIONS OF THE ANALYSIS: The following assumptions were made:

1. Construction in Alternative 1 will take place over a 2-year period with 60 percent occurring in 1990.

2. Renovation in Alternative 2 will take place for existing facilities used by the 801st Maintenance Battalion. The renovation will be done in Fiscal Year (FY) 1990 and will include interior and exterior wall repair, electrical wiring replacement, new heating units, new vehicle exhaust systems, new siding, new windows an overhead doors, and wall insulation. Seventy-five percent of the existing facilities must receive major structural repair and new roofs in FY 1990 and again in FY 2005 and again in FY 2015.

3. Existing gravel areas used by the 801st Maintenance Battalion will be replaced by asphalt paving as part of the renovation work in FY 1990 for Alternative 2.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS: There were two alternatives considered:

1. MCA Construction of a consolidated vehicle maintenance facility for the 801st Maintenance Battalion.

2. Renovation of Existing Facilities now used by the 801st Maintenance Battalion. The existing facilities are located from one to four mile apart. Thus, personnel must spend time in travel between shops and loading and unloading parts and equipment.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC
1 MCA Construction	$21,336,515	$2,309,840
2 Renovate	$21,916,664	$2,372,646

RESULTS AND RECOMMENDATIONS:

The results of this economic analysis indicate that the most economical alternative is MCA Construction of a consolidated maintenance facility.

Figure 5. ECONPACK E/A for a vehicle maintenance shop.

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

Sources:

1. An Economic Assessment of Renovating Temporary Wood Frame Buildings, USACERL Technical Report N-88/21 Aug 88.

2. Building Constructin Cost Data, 1986, R.S. Means.

3. Table 2, Total O&M Costs, $/Square Foot/Year, October 1980, US Army Corps of Engineers, DD 1391 Preparation Course Test.

4. IFS R&D Report for Fort Campbell Buildings, 22 Sep 88 for FY 87-88.

5. Engineering Technical Letter 1110-3-309, Guidelines for Using Building Design Energy Budgets, Table 1, Interim Design Energy Budget.

6. Estimating Section, DEH, Fort Campbell.

7. Special methods time study performed by 801st Maintenance Battalion.

8. FORSCOM-TRADOC Resource Factor Handbook, April 1987, for labor-hour rates.

9. US General Services Administration (GSA) Federal Motor Fleet Report.

Derivation:

1. MCA Construction: Initial Investment from Source 2, above.

2. MCA Construction: O&M Costs from Source 3 and 5, above.

   a. Maintenance Costs: $4.00 per Square Foot per Year X 131,702 Square Feet = $526,808.

   b. Energy Costs: $4.00 per Square Foot per Year X 131,702 Square Feet = $526,808.

3. Renovate Existing Facilities: Initial Costs from Sources 1 and 6, above.

   a. Building Renovation: $19.25 per Square Foot X 139,206 Square Feet = $2,679,715.

   b. Roof Replacement: Seventy Five percent of the roofs of the existing facilities must be replaced in 1990. The cost is estimated as follows: $1.60 per Square Foot X .75 X 139,206 Square Feet = $167,047.

   c. Asphalt Paving: $23 per Square Yard X 54,000 Square Yars = $1,242,000.

Figure 5. (Cont'd).

4. Renovate Existing Facilities: Periodic Roof Replacement from Source 6, above. The remaining 25 percent of the roofs on existing facilities will need replacement in FY 2000 and again in FY 2015. The 75 percent of the roofs included in the initial renovation will need replacement in FY 2005. A 15-year life is expected on these roofs. Calculations are as follows:

FY 2000: $1.60 per Square Foot X .25 X 139,206 Square Feet = $55,682.

FY 2005: $1.60 per Square Foot X .75 X 139,206 Square Feet = $167,047.

FY 2015: $1.60 per Square Foot X .25 X 139,206 Square Feet = $55,682.

5. Renovating Existing Facilities: Annual O&M Costs from Sources 4, 5, 7, 8, and 9, above.

a. Energy Costs. Sixty Five percent of the renovated facilities require HVAC. Therefore, energy costs are calculated as follows: %5.00 per Square Foot X .65 X 139,206 Square Feet = $452,420.

b. Maintenance Costs. $5.00/SF X 139,206 SF = $696,030.

c. Lost Time Due to Dispersed Facilities. A time study indicated that the labor involved is 3/4 hour on each of 232 daily trips during each of the 246 work-days per year between facilities and will be lost, compared with the process involved with the consolidated facility. An average fully burdened labor rate of $17.00 per hour was used in the following calculation:

.75 hour/trip X 232 trips/day X 246 days/year X $17.00/hour = $727,668.

d. Additional Equipment Utilization Due to Dispersed Facilities. The time study referenced in Source 7, above, also indicated an average distance of two miles per trip that could be eliminated with the use of a consolidated maintenance facility. Using an average cost of $.40 per mile for the light duty trucks used to make these trips yields the following additional cost:

2 miles/trip X 232 trips/day X 246 days/year X $.40 per mile = $45,658 per year.

Figure 5. (Cont'd).

EXECUTIVE SUMMARY REPORT

PROJECT TITLE: Family Housing
PROJECT OBJECTIVE: Provide Housing for 300 Families
DISCOUNT RATE: 9.60%
PERIOD OF ANALYSIS: 21 YEARS
START YEAR: 1986
BASE YEAR: 1986

ASSUMPTIONS OF THE ANALYSIS:

1. Background. Section 801 of the Military Construction Authorization Act of 1984 authorized several pilot studies to determine the cost effectiveness of a lease program to obtain additional housing facilities. Fort Hood, TX was one of the locations selected for this pilot program. These housing facilities would be available for beneficial occupancy in FY88.

Major provisions set forth in this program are as follows:

(1) Occupants would forfeit Basic Allowance for Quarters and Variable Housing Allowance in return for assigned quarters.

(2) The Government would pay all rent, utilities, and administrative costs.

(3) The program cannot be applied to existing housing.

(4) The new housing units are required to be constructed in conformance with DOD specification.

(5) The leasing agreement cannot exceed 20 years.

(6) A validated deficit in military housing must exist in the general area.

(7) Use of military controlled housing must have exceeded 97 percent occupancy for 18 consecutive months preceding an agreement.

(8) Priority shall be given to military families.

(9) The new housing units may be built on private or Government-owned land.

b. Assumptions.

(1) The structure life for MCA construction is assumed to be 40 years.

(2) New housing would be constructed on Government-owned land.

(3) In order to facilitate the estimate of implied residual value (MCA Program), it is assumed that a demand for the housing facilities will exist beyond the analysis period (FY 2006).

Figure 6. ECONPACK E/A for a family housing complex.

(4) A scheduled beneficial occupancy date (BOD) will be set to occur upon completion and acceptance of the housing project by the Government in FY 88.

(5) A discount rate of 9.6% is applied per OMB and OSD guidelines.

(6) Price level changes due to inflation are included in this analysis. OMB/OSD inflation rate guidelines are utilized on all applicable cost items.

(7) A residual value is included in the analysis.

(8) Expense items which would be the same in both alternatives are considered "wash" costs and are not included in the analysis.

(9) The 801 Program assumes 18-year accelerated depreciation.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS: Two potential housing alternatives for Fort Hood were analyzed:

a. MCA Program. Construction of 300 new family housing units over a 2-year period from FY 86 to FY 88, with a BOD of mid FY 88.

b. 801 Build-to-Lease Program. The Army would enter into a long-term agreement to lease 300 rental units to be constructed by a private developer with scheduled BOD of mid FY 88.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC
1 MCA Construction	$16,836,670	$1,892,367
2 Build-to-Lease	$15,297,988	$1,719,426

RESULTS AND RECOMMENDATIONS: The requirement to provide needed family housing for enlisted personnel at Fort Hood can best be accomplished through the 801 Build-to-Lease Program.

ACTION OFFICER: John Doe
ORGANIZATION : Fort Hood, Texas

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

Alternative 1: MCA Construction.

Expense Item 1: Construction Cost. MCA construction costs were based on estimates developed by personnel in the US Army Engineering and Housing Support Center (CEHSC-F) Family Housing Division, using the Tri-Service Cost Model. Costs were calculated as follows:

Figure 6. (Cont'd).

5-Foot Line Cost:

300 Units X 968.6 Average Net Square Feet per Unit X $46 per Square Foot = $13,267,000

Project Factor:

Area Cost Factor		Project Size		Unit Size
.89	X	.98	X	1.0 = .87

Housing Cost: 5-Foot Line Cost X Project Factor = $11,629,000

Supporting Cost: 30% of Housing Cost = $ 3,489,000. Includes site preparation, roads and paving, utilities, recreation, and landscaping.

Special Construction (Sewage Treatment Facility): $300,000

Summary: Construction Sub-total = $11,629,000 + $3,489,000 + $300,000 = $5,418,000
Contingency = 0.05 X $15,418,000 = $770,900
SIOH = 0.055 X ($15,418,000 + $770,900) = $890,390

Construction Total (rounded) = $17,079,000

Dwelling Unit Cost = $56,930

Expense Item 2: Maintenance and Repair: Dwellings. Estimates for maintenance and repair (M & R) were based upon the assumption that these costs would be similar to the current installation expenses on units of comparable size and age. Historical M & R data (1982 through 1984) from IFS were analyzed to yield an average annual dwelling unit expense of $900. M & R costs for FY 87 assume only 180 of the dwelling units will be occupied. Costs for FY 88 and beyond are for the total 300 dwelling units. BOMA age escalation factors for maintenance of a facility are applied.

Expense Item 3: Maintenance: Installed Equipment. New refrigerators, ranges, and ovens will be installed in the new housing units. Initial issue costs are included as part of the construction costs. Based upon historical DEH service call records, one service call can be expected each year for half of the dwelling units. It is assumed that all equipment will be replaced in FY 98. Costs are as follows:

FY 87: 90 DUs X $30 per Service Call per Unit = $2700
FY 88 - 97: 150 DUs X $30 per Service Call per Unit per Year = $4500
FY 99 - 06: 150 DUs X $30 per Service Call per Unit per Year = $4500

Figure 6. (Cont'd).

Expense Item 4: Replacement: Installed Equipment. Based upon data obtained from GSA catalogs, $1026 per dwelling unit was estimated for initial issue of installed equipment. The expected useful life of this equipment was taken from OMB Circular A-104.

Expense Item 5: Insurance. This expense item is the imputed cost of insurance. Estimates of this cost were obtained from commercial insurance sources near Fort Hood. Using a $500,000 liability limit, these sources indicated a cost of $35 per dwelling unit.

Expense Item 6: Administration. Operation expenses included in the 801 program provide for the services of an on-site manager, inspector, and maintenance technician to insure that the dwelling units are operated and maintained in accordance with the terms of the lease. Such expenses are implicitly built into the developer's proposal costs. Since installation housing management services currently exist under the MCA option, the Government would only have to expand these services. It is estimated that two additional employees will be required for this purpose. The fully burdened labor rates for these two employees was obtained from the Fort Hood Civilian Personnel Office and totaled $64,100 per year.

Expense Item 7: Services. Cost elements in the services account include refuse collection/disposal, entomological, and custodial services. Estimates of prior-year services expenses (1982-1984) were obtained from the appropriate housing management Army Management Structure (AMS) accounts from the budget office at Fort Hood. An estimate of annual cost breakdown of each of these services is shown below.

Cost Element	Annual Cost	Cost per Unit	
Refuse Collection/Disposal	$158,622.26	$ 75.64	
Entomology Services	125,164.16	59.69	
Custodial	27,055.00	12.90	
	Total (FY 84)		$148.23
	Total (Adjusted to FY 86)		$159.20

Alternative 2: Build-to-Lease. All costs for this alternative were taken directly from the actual preferred proposal for the project. Units accepted by the Government will be leased for a 20-year rental term.

Expense Item 1: Shelter Rent. This expense item includes all construction, operations, and initial equipment expenses incurred by the developer.

Excluded are maintenance expenses and payable real estate taxes. The monthly cost per unit to the Government will be $354.58. This translates to a life-cycle cost as follows (assuming 180 units are available for occupancy in FY 87):

Year	Number of Units	Months	Cost per Month	Total
FY 87	180	12	$364.58	$787,500
FY 88-06	300	12	$364.58	$1,312,500

Figure 6. (Cont'd).

Expense Item 2: Maintenance Rent. This cost element is also taken directly from the preferred proposal for the project and is intended to include the developer's cost to maintain and repair the project. This rent is to be increased or decreased at the beginning of the second and subsequent years of the lease based upon the increase or decrease of the Housing, Shelter, Maintenance and Repair Index for the preceding 12 months of the "Economic Indicators" prepared for the Joint Economic Committee of the Congress by the Council of Economic Advisors. For the purpose of this economic analysis, it is assumed that the OMB/OSD inflation indices supplied will equate to changes in the "Economic Indicators" for the analysis period. The rental costs were calculated as follows:

Year	Number of Units	Months	Cost per Month	Total
FY 87	180	12	$126.31	$272,838
FY 88-06	300	12	$126.31	$454,730

Expense Item 3: Payable Real Estate Taxes. The Request for Proposal for the project specified that the Government will pay 80% of any increase in total general real estate taxes over those levied in the second lease year. Since the present schedule calls for the units to be delivered in FY 88, FY 89 is considered the second year of the lease and the base year for any increase in real estate taxes.

General real estate taxes would be those assigned on an ad valorem basis against all taxable real property in the taxing authority's jurisdiction. The applicable tax rate of $1.37 per $100 of assessed valuation for this expense item were obtained from the local assessor.

Using the Effective Tax Rate multiplier against 80% of the estimated market value of the land and structure of the project yields the schedule of costs shown in the Life-Cycle Cost Report for this alternative.

Figure 6. (Cont'd).

Cost Estimating Worksheet

The worksheet shown in Figure 7 can be used to record many of the costs involved in developing an E/A. The form is designed so, upon its completion, costs can be entered into ECONPACK as expense items. The top portion of the form is used to record basic identifying information about the cost to be estimated: Project Name, Alternative Name, Period of Analysis, Cost Description, Unit of Measure (e.g., square feet, kilowatt-hours, dollars, tons), and the Data Source(s). The next section provides space to perform annual cost calculations. In this space, the analyst should record the number of units and multiply this number by the unit cost obtained from the appropriate data source. The result is the annual cost (shown as TOTAL 1 on the worksheet). Following that is a section that allows for incorporation of any adjustment factors (e.g., geographic location, inflation). The last section is used for recording cost estimates for individual years, which can be entered into ECONPACK as the values for the expense item.

Figure 8 shows a completed worksheet. In this example, Fort Lewis, WA, programmed a requirement in FY 1984 for a barracks of 124,640 sq ft. The building design used was identical to a barracks constructed at Fort Hood, TX, in 1978. The problem was to estimate annual maintenance requirements for the New Construction alternative beyond the 2-year construction period for the remaining 28 years of the analysis period. Rather than using local estimates for somewhat similar facilities at Fort Lewis, the analyst contacted personnel in the Engineer Resources Management Division (ERMD) at Fort Hood to take advantage of their experience at maintaining an identical facility. Fort Hood ERMD personnel responded with an FY 1981 cost of $0.62 per square foot to maintain their facility. This information and three adjustment factors were enough to complete the first two sections of the worksheet.

Two of the adjustment factors, Cost Growth and Area Cost Factor, were taken from AR 415-17.[4] The other factor, Escalation for maintenance of a facility, was taken from Appendix F of this guide.

To complete the remaining two sections of the worksheet, the values of the adjustment factors had to be calculated and applied to the FY 1981 maintenance cost. According to AR 415-17 indices, the Cost Growth adjustment factor was calculated as the ratio of the FY 1986 factor to the FY 1981 factor as follows:

Cost Growth Adjustment Factor = 1619 / 1192 = 1.36;

and the Location Adjustment Factor between Fort Lewis and Fort Hood was calculated as:

Location Adjustment Factor = 1.15 / 0.98 = 1.17.

The maintenance escalation factor was taken from the table in Appendix F of this report, noting that maintenance requirements would not begin until Year 3 in this period of analysis. The dollar amounts generated in the Adjustment Factors section of the worksheet were then transcribed to the Cost Stream section and input to ECONPACK as the annual maintenance expense item for this alternative.

[4] AR 415-17, *Cost Estimating for Military Programming* (HQDA, 15 February 1980).

COST ESTIMATING WORKSHEET

Project Name: ____________________

Alternative Name: ____________________

Period of Analysis: ____________

Cost Description: ____________________

Unit of Measure: ____________________

Data Source(s): ____________________

ANNUAL COST CALCULATIONS

Unit of Measure (from above):		______
Number of Units:		______
Unit Cost:	(X)	______
TOTAL 1	(=)	______

ADJUSTMENT FACTORS

	Factor 1 Value		Factor 2 Value		Factor 3 Value		Factor 4 Value		TOTAL 1 (from above)		ANNUAL TOTAL
	______		______		______		______				
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______
During Year(s) ___ thru ___	______	(X)	______	(X)	______	(X)	______	(X)	______	(=)	______

COST STREAM ($000)

Year	1	2	3	4	5	6	7	8	9	10
Dollar Amount	____	____	____	____	____	____	____	____	____	____
Year	11	12	13	14	15	16	17	18	19	20
Dollar Amount	____	____	____	____	____	____	____	____	____	____
Year	21	22	23	24	25	26	27	28	29	30
Dollar Amount	____	____	____	____	____	____	____	____	____	____

Figure 7. Cost estimating worksheet (blank).

COST ESTIMATING WORKSHEET

Project Name: Barracks with Dining Facility

Alternative Name: New Construction

Period of Analysis: *30 Years*

Cost Description: *Annual Maintenance Requirements*

Unit of Measure: *Square Feet*

Data Source(s): *Maint. Records from Ft Hood; Adjustment Factors from AR 415-17; App. A of this Guide*

ANNUAL COST CALCULATIONS

Unit of Measure (from above): *Square Feet* **Number of Units:** *124,640*

Unit Cost: (X) $ .62

TOTAL 1 (=) $ 77,277

ADJUSTMENT FACTORS

		Factor 1 Value ESCALATION		Factor 2 Value COST GROWTH		Factor 3 Value LOCATION		Factor 4 Value		TOTAL 1 (from above)		ANNUAL TOTAL
During Year(s)	3 thru 12	1.00	(X)	1.36	(X)	1.17	(X)		(X)	$77,277	(=)	$ 122,363
During Year(s)	13 thru 22	1.40	(X)	1.36	(X)	1.17	(X)		(X)	$77,277	(=)	$ 172,148
During Year(s)	23 thru 30	1.90	(X)	1.36	(X)	1.17	(X)		(X)	$77,277	(=)	$ 233,630
During Year(s)	thru		(X)		(X)		(X)		(X)		(=)	

COST STREAM ($000)

	Year	1	2	3	4	5	6	7	8	9	10
Dollar Amount				$ 123.0	$ 123.0	$ 123.0	$ 123.0	$ 123.0	$ 123.0	$ 123.0	$ 123.0
	Year	11	12	13	14	15	16	17	18	19	20
Dollar Amount		$ 123.0	$ 123.0	$ 172.1	$ 172.1	$ 172.1	$ 172.1	$ 172.1	$ 172.1	$ 172.1	$ 172.1
	Year	21	22	23	24	25	26	27	28	29	30
Dollar Amount		$ 172.1	$ 172.1	$ 233.6	$ 233.6	$ 233.6	$ 233.6	$ 233.6	$ 233.6	$ 233.6	$ 233.6

Figure 8. Sample cost estimating worksheet (completed).

5 SUMMARY

This report has presented key concepts, procedures, and issues pertaining to the cost estimation that is a part of the economic analyses required for most MCA projects.

The Army's ECONPACK and PC ECONPACK computer software automate the analysis and reporting aspects of the E/A. These programs cannot gather and apply cost data; this must be done by an analyst, but it is inherently the most difficult aspect of the E/A to perform accurately because it involves unknown future values such as fuel prices and rate of inflation.

To estimate construction and life-cycle costs most effectively the analyst must look at the feasible alternatives for approaching an MCA project (e.g., renovation, addition, new construction), determine which Cost Kinds apply to each alternative, locate the best sources of cost information available (e.g., DEH data, non-Army Government records, commercial information sources), and select the method of analysis that will work most effectively with the available data.

Study of the sample analyses provided in this report can offer insight into the cost estimation process for E/As, especially for the less experienced analyst. Organizing data using the worksheet provided (Figure 7) can facilitate the input of the data to ECONPACK.

REFERENCES

Air Force Manual, *Military Construction Program Economic Analysis Manual* (Headquarters, U.S. Air Force [HQUSAF], June 1987).

Army Regulation (AR) 11-18, *The Economic Analysis Program, Department of the Army* (HQDA, 7 May 1990).

AR 415-15, *Military Construction, Army (MCA) Program Development* (Headquarters, Department of the Army [HQDA], 1 December 1983).

AR 415-17, *Cost Estimating for Military Programming* (HQDA, 15 February 1980).

AR 415-20, *Project Development and Design Approval* (HQDA, 28 March 1974).

AR 415-35, *Minor Construction, Emergency Construction, and Replacement of Facilities Damaged or Destroyed* (HQDA, 15 October 1983).

Department of the Army Pamphlet (DAPAM) 210-6, *Economic Analysis of Army Housing Alternatives: Concepts, Guidelines, and Formats* (HQDA, 27 August 1986).

DAPAM 420-8, *Facilities Engineering Management Handbook* (HQDA, September 1978).

NBS Handbook 135, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis, Annual Supplement* (U.S. Department of Commerce, National Institute of Standards and Technology, 1988).

Office of Management and Budget (OMB) Circular A-76, *Policies for Acquiring Commercial or Industrial Products and Services of Government Use* (OMB, 4 August 1983).

OMB Circular A-104, *Evaluating Leases of Capital Assets* (OMB, 1 June 1986).

Stewart, Rodney D., *Cost Estimating* (John Wiley & Sons, Inc., 1982).

Stewart, Rodney D., and A.L. Stewart, *Microestimating for Civil Engineers* (McGraw-Hill Book Company, 1986).

TRADOC-FORSCOM Resource Factor Handbook, *Volume I, Cost Planning Factors* (U.S. Army Training and Doctrine Command, U.S. Army Forces Command, April 1988).

Neathammer, Robert, *Economic Analysis: Description and Method*, Technical Report P-89/08/ ADA204264 (U.S. Army Construction Engineering Research Laboratory, December 1988).

U.S. Army Corps of Engineers Manual, *PC Econpack Users Report* (Department of the Army, November 1987).

APPENDIX A:

AN APPROACH TO ESTIMATING THE COST OF A CAPITAL LEASE

Government ownership or construction of a capital asset is not always the most economical means of obtaining use of a facility. It may be less expensive to pay rent for the use of an asset. Leasing is sometimes an economical alternative to constructing or renovating a facility.

Types of Leases

There are two types of leases: operating leases and capital leases. Both are defined below to show how they are different, but only Capital Leases are discussed in detail.

Operating Leases

In an operating lease, a rental fee is charged to the user (lessee) over a lease term. Ownership resides with the owner (lessor) and is not transferred to the lessee. The rent charged is not intended to cover (capitalize) construction costs. The lease period is usually less than the expected life of the asset or facility, and therefore, the lessor expects to recover the construction costs either through subsequent leases or by sale of the facility. For example, if the Government needs to obtain administrative space, it pays a lease rental fee, and the lease is renewed every 5 years. Annual costs of rental space for operating leases can normally be obtained from the General Services Administration (GSA).

Capital Leases

In a capital lease, three parties are involved: the lessee, the lessor, and a third party to provide the financing. Third-party contracting is a term often used to describe capital leases. The difference between capital and operating leases is that a capital lease allows the lessor to recover the construction costs during the lease term. In other words, the lessor receives rent that equals the full price of the asset plus a return on investment.

Title 10 of the United States Code governs these leases: Section 2809—Long-Term Facilities Leases; Section 2812—Lease Purchase of Administrative Facilities; Section 2821—Army Family Housing Guarantee 802 Housing; and Section 2828—Army Family Housing Build to Lease 801 Housing.

Estimating the Rental Charge

To estimate the rental charge for a capital lease, one approach is to estimate the following costs from the lessor's perspective: construction cost, lease term, and interest rate.

Construction Cost

An appropriate construction cost can be obtained from standard construction cost estimating manuals such as Means or Dodge. Construction costs for Government and private sector are usually not the same and should not be assumed identical without further research. Often, construction cost manuals provide

estimates for both Government and private-sector construction for similar quality. Specifications in the private sector may be less stringent and provide the basis for a reduction in construction costs. As an example, assume research into construction costs for an administrative facility reveals average costs as in Table A.

Lease Term

The term of the lease may be governed by Congressional legislation or specified in the lease contract. Generally, lease terms are between 20 and 32 years.

Interest Rate

The interest rate is the commercial loan rate a bank would charge a private developer for borrowing money. The assumption is that the borrowed money is used to construct a facility to lease to the Government. The private developer must amortize (pay back) this loan to the bank and will charge the Government an annual rent sufficient to cover it. A rule of thumb to use is the prime lending rate plus two percentage points. Using a simple amortization calculation, a "ballpark" rent can be estimated as follows (assume an interest rate of 10 percent):

1. Government construction cost: $45,000,000
2. Developer's Cost (17 percent less): $37,350,000
3. Lease term: = 20 years
4. Interest rate (prime rate + 2): i = 10 + 2 = 12%

Thus, private-sector construction costs were estimated to be 17 percent less ($92.11/$110.73) than the Government construction cost.

Table A

Average Costs for Hypothetical Administrative Facility Using Cost Multipliers

	Cost per Square Ft	Design	Current-Year Factor	Local Factor	Total
Government Building	$98.59	1.069	1.02	1.03	$110.73
Commercial Building	$82.95	1.057	1.02	1.03	$ 92.11

The annual rent is calculated by multiplying the developer's cost by the capital recovery factor (CRF) from the following formula:

$$CRF = \frac{i\,(\,1 +)^n}{(\,1 + i\,)^n - 1} = \frac{0.12\,(\,1 + 0.12\,)^{20}}{(\,1 + 0.12)^{20} - 1} = 0.1339$$

Thus, the annual rent, R, is estimated to be R = \$37,350,000 X 0.1339 = \$5,001,165.

Of course, there are many other ways to obtain rent estimates. But as a first cut, this method provides an order of magnitude that is reasonable.

APPENDIX B:

LIST OF REPRESENTATIVE COMMERCIAL PUBLICATIONS FOR COST SOURCES

The following is a list of several commercial publications appropriate for use in estimating costs during the development of an economic analysis. Most publications can be purchased for less than $100 and can be ordered from R.S. Means Co., 100 Construction Plaza, Kingston, MA 02364; or Dodge Cost Systems, McGraw-Hill Information Systems Company, P.O. Box 28, Princeton, NJ, 08542.

Titles Published by R.S. Means and Co.

Building Construction Cost Data
Repair and Remodeling Cost Data
Square Foot Costs
Interior Cost Data
Residential Cost Data
Light Commercial Cost Data
Facilities Cost Data
Building Construction Cost Data—West
Square Foot Estimating
Estimating and Analysis for Commercial Renovation
Home Improvement Cost Guide
Unit Price Estimating
Interior Estimating
Facilities Maintenance Management
Hazardous Waste Management
Repair & Remodeling Estimating

Titles Published by Dodge Cost Systems

Assemblies Cost Data
Unit Cost Data
Square Foot Cost Data
Remodeling and Retrofit Cost Data

APPENDIX C:

INFLATION AND ESCALATION INDICES FOR ENERGY COSTS

This appendix provides a source and example calculations for developing projected fuel prices. The three tables and other information presented here have been extracted from National Bureau of Standards (NBS) Handbook 135.[5] These tables are updated periodically. The analyst should obtain the latest version from the mechanical design branch/section of the Corps district office.

Default Values

Table C1 presents average 1988 fuel prices for the four census regions and for the U.S. as a whole. These prices are used as default values for fuel prices only if actual fuel prices are unknown.

Inflation Indices

Table C2 presents projected average fuel price indices for Census Region 1 and for the U.S. as a whole. These are multipliers which, when applied to the 1988 prices, provide estimates of the corresponding future-year prices in 1988 dollars. Note that the resulting price estimates are in constant dollars, exclusive of general price inflation. Constant dollars are used when discounting is performed with rates that do not include general price inflation.

Example of How To Use the Indices

To estimate the price of industrial steam coal in year 2005 in Connecticut, go to Table C2, find the year 2005 index for industrial steam coal (1.27), and multiply by the 1988 price for industrial steam coal in Connecticut. The result will be given in 1988 dollars.

Escalation Rates

Table C3 presents the projected average fuel price escalation rates (percentage change compounded annually) for six selected periods from 1988 to 2013 for Census Region 4 and for the U.S. as a whole. Note that these are real rates, exclusive of general price inflation. Their use results in prices expressed in constant dollars.

The escalation rates consolidate the information provided by the inflation indices (Table C2) so trends in projected price changes can be seen at a glance. They are provided primarily to accommodate those who use computer programs that require escalation rates as inputs.

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[5] NBS Handbook 135, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis, Annual Supplement* (U.S. Department of Commerce, National Institute of Standards and Technology [NIST], 1984).

Unless there is a compelling reason to use escalation rates, it is recommended that the analyst use the inflation indices (e.g., Table C2 to estimate future-year energy prices; the inflation indices include year-to-year information rather than averages over a range of years, and they are easier to use.

Example of How To Use the Escalation Rates

To estimate the price of residential distillate in 1993 (p_{93}) in Wyoming using the escalation rates, go to Table C3 and find the 1988-1990 and 1990-1995 escalation rates for residential distillate (3.6 percent and 2.9 percent per year, respectively). Assuming the actual 1988 price of residential distillate is unknown, go to Table C1 and find the default 1988 price (p_{88}) for Census Region 4 ($6.67/million Btu). Enter these values into the following formula and solve for the 1993 energy price (stated in 1988 dollars):

$$p_{93} = p_{88} \times (1 + e_1)^{k_1} \times (1 + e_2)^{k_2} \qquad \text{[Eq C1]}$$

$$= \$6.67 \times (1 + 0.036)^2 \times (1 + 0.029)^3$$

$$= \$7.80$$

where e_1, e_2 = annual compound escalation rates for periods 1,2 from Table C3 (in decimal form), and

k_1, k_2 = number of years over which escalation rates e_1, e_2 occur.

For further explanation of how to use these tables, refer to NBS Handbook 135, Appendices C and G.

Table C1

Regional and U.S. Average 1988 Fuel Prices
By End-Use Sector and Major Fuel*
(1988 $ /Million Btu)

Sector/Fuel	CENSUS REGION** 1	2	3	4	U.S. AVERAGE
Residential					
Electricity	29.46	23.74	21.14	19.12	22.53
Distillate Fuel	7.15	6.70	7.15	6.67	7.06
Liquified Petroleum Gas	12.35	9.67	10.97	10.99	10.57
Natural Gas	6.88	5.31	5.43	5.24	5.64
Commercial					
Electricity	27.84	21.84	19.27	19.62	21.44
Distillate Fuel	5.06	4.63	4.76	4.79	4.84
Residual Fuel	2.80	3.16	2.49	3.04	2.74
Natural Gas	5.56	4.43	4.49	5.11	4.79
Steam Coal	1.63	1.81	1.26	1.63	1.62
Industrial					
Electricity	17.22	14.59	13.38	13.58	14.28
Distillate Fuel	4.71	4.64	4.76	4.60	4.69
Residual Fuel	2.88	2.67	2.81	2.69	2.79
Natural Gas	3.70	3.18	2.39	2.90	2.69
Steam Coal	1.69	1.57	1.66	1.70	1.63
Transportation					
Motor Gasoline	7.73	7.89	7.74	7.77	7.78

*Regional fuel prices are based on an assumed 1988 world oil price of $17.21/barrel.

**Northeast Census Region = Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania

Midwest Census Region = North Dakota, South Dakota, Minnesota, Wisconsin, Michigan, Ohio, Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri

South Census Region = Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Florida, Georgia, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas

West Census Region = Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, and Hawaii

Table C2

Projected Average Fuel Price Indices Tied to the Value of the Dollar in 1988, By End-Use Sector and Major Fuel (Northeast Census Region)

PROJECTED AVERAGE FUEL PRICE INDICES
(1988 = 1.00)

Sector/Fuel	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential													
Electricity	1.00	1.01	0.99	0.99	0.98	0.97	0.97	0.97	0.98	0.99	1.00	1.01	1.02
Distillate Fuel	1.00	1.05	1.07	1.09	1.11	1.14	1.18	1.22	1.28	1.33	1.38	1.43	1.47
Liquified Petroleum Gas	1.00	1.05	1.07	1.07	1.08	1.10	1.14	1.18	1.23	1.28	1.32	1.35	1.37
Natural Gas	1.00	1.01	1.02	1.03	1.04	1.06	1.09	1.12	1.15	1.19	1.23	1.26	1.28
Commercial													
Electricity	1.00	1.01	0.99	0.99	0.97	0.97	0.97	0.97	0.98	0.99	1.00	1.02	1.02
Distillate Fuel	1.00	1.08	1.10	1.13	1.15	1.20	1.26	1.32	1.39	1.47	1.54	1.61	1.66
Residual Fuel	1.00	1.05	1.04	1.05	1.05	1.11	1.19	1.29	1.41	1.53	1.63	1.70	1.74
Natural Gas	1.00	1.01	1.01	1.02	1.03	1.04	1.07	1.10	1.13	1.16	1.20	1.23	1.25
Steam Coal	1.00	1.01	1.03	1.05	1.07	1.09	1.11	1.13	1.14	1.16	1.17	1.19	1.21
Industrial													
Electricity	1.00	1.02	0.99	0.98	0.96	0.95	0.94	0.95	0.96	0.98	1.00	1.03	1.03
Distillate Fuel	1.00	1.08	1.10	1.13	1.16	1.21	1.27	1.34	1.42	1.50	1.58	1.65	1.71
Residual Fuel	1.00	1.05	1.04	1.05	1.05	1.10	1.18	1.28	1.40	1.52	1.61	1.68	1.72
Natural Gas	1.00	1.02	1.03	1.06	1.08	1.12	1.17	1.23	1.28	1.36	1.42	1.48	1.53
Steam Coal	1.00	1.02	1.03	1.05	1.06	1.08	1.10	1.11	1.12	1.13	1.15	1.16	1.18
Transportation													
Motor Gasoline	1.00	1.02	1.04	1.05	1.05	1.08	1.14	1.20	1.28	1.34	1.40	1.44	1.47

PROJECTED WORLD OIL PRICE INDICES
(1988 = 1.00)

Oil Price Assumption	1.00	1.05	1.06	1.07	1.07	1.12	1.21	1.33	1.47	1.60	1.71	1.79	1.83

PROJECTED AVERAGE FUEL PRICE INDICES
(1988 = 1.00)

Sector/Fuel	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Residential													
Electricity	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05
Distillate Fuel	1.49	1.51	1.52	1.55	1.57	1.58	1.59	1.60	1.61	1.62	1.63	1.64	1.65
Liquified Petroleum Gas	1.39	1.41	1.43	1.45	1.47	1.48	1.48	1.49	1.51	1.52	1.52	1.53	1.55
Natural Gas	1.30	1.32	1.33	1.35	1.37	1.38	1.39	1.39	1.41	1.42	1.42	1.43	1.45
Commercial													
Electricity	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05
Distillate Fuel	1.68	1.70	1.72	1.75	1.77	1.79	1.80	1.81	1.82	1.83	1.84	1.85	1.87
Residual Fuel	1.76	1.78	1.81	1.84	1.86	1.87	1.88	1.89	1.91	1.92	1.93	1.94	1.96
Natural Gas	1.27	1.29	1.30	1.32	1.34	1.35	1.35	1.36	1.37	1.38	1.39	1.40	1.41
Steam Coal	1.23	1.25	1.26	1.28	1.30	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45
Industrial													
Electricity	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.06	1.06
Distillate Fuel	1.73	1.75	1.77	1.80	1.82	1.83	1.85	1.86	1.87	1.88	1.90	1.91	1.92
Residual Fuel	1.74	1.76	1.79	1.81	1.84	1.85	1.86	1.87	1.89	1.90	1.91	1.92	1.94
Natural Gas	1.55	1.57	1.59	1.61	1.63	1.64	1.65	1.66	1.68	1.69	1.70	1.71	1.72
Steam Coal	1.20	1.21	1.23	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.38	1.39	1.41
Transportation													
Motor Gasoline	1.49	1.51	1.53	1.55	1.57	1.58	1.59	1.60	1.61	1.62	1.63	1.64	1.66

PROJECTED WORLD OIL PRICE INDICES
(1988 = 1.00)

Oil Price Assumption	1.86	1.88	1.90	1.93	1.96	1.97	1.98	1.99	2.01	2.02	2.04	2.05	2.07

Table C3

Projected Average Fuel Price Escalation Rates
Exclusive of General Price Inflation
by End-Use Sector and Major Fuel
(Percentage Change Compounded Annually, West Census Region)

Sector/Fuel	1988 to 1990	1990 to 1995	1995 to 2000	2000 to 2005	2005 to 2010	2010 to 2013
Residential						
Electricity	-0.20	0.20	1.30	0.30	0.20	0.24
Distillate Fuel	3.60	2.90	3.90	1.40	0.70	0.68
Liquified Petroleum Gas	3.60	2.20	3.40	1.40	0.70	0.69
Natural Gas	1.20	2.60	3.30	1.40	0.70	0.69
Commercial						
Electricity	-0.20	0.20	1.30	0.30	0.20	0.25
Distillate Fuel	5.00	3.90	4.90	1.40	0.70	0.68
Residual Fuel	2.00	4.00	5.80	1.40	0.70	0.66
Natural Gas	0.80	1.80	2.80	1.40	0.70	0.71
Steam Coal	3.20	3.00	2.90	1.40	1.40	1.40
Industrial						
Electricity	-0.30	0.30	1.80	0.30	0.20	0.24
Distillate Fuel	5.20	4.10	5.00	1.40	0.70	0.70
Residual Fuel	2.20	4.50	6.30	1.40	0.70	0.71
Natural Gas	2.20	4.40	5.20	1.40	0.70	0.70
Steam Coal	2.90	2.70	2.60	1.40	1.40	1.38
Transportation						
Motor Gasoline	1.70	3.00	4.10	1.40	0.70	0.67
World Oil Price Assumption	3.00	4.70	6.50	1.40	0.70	0.68

APPENDIX D:

CALCULATING SALVAGE VALUE IN A LEASE-VERSUS-BUY ANALYSIS

In a lease-versus-buy analysis, the residual or salvage value is a product of four components:

1. Initial cost of capital: facility and land
2. Depreciation (facility) and appreciation (land)
3. Inflation
4. Discount rate.

Since it is generally agreed that a facility depreciates while land appreciates, different salvage values must be calculated for facilities and for land. Depreciation and appreciation factors can be found in OMB Circular A-104,[6] there referred to as "building decay-obsolescence" and "site appreciation factors," respectively. As an example, suppose the analysis contains the following factors:

Facility cost: $5,000,000
Land cost: $1,000,000
Construction period: 2 years
Facility economic life: 25 years
Period of analysis: 27 years.

The facility and land salvage values would be calculated separately as follows:

Facility Salvage Value—The 25-year decay-obsolescence factor from OMB Circular A-104 is 0.65139. This factor is multiplied by the facility cost—$5,000,000 in this example—to yield a salvage value of $3,256,960.

Land Salvage Value—The 27-year site appreciation factor from OMB Circular A-104 is 1.4948. This factor is multiplied by the land cost of $1,000,000 in this example to yield a salvage value of $1,494,800.

These two salvage values are added together to yield a total one-time salvage value of $4,751,750 (in current dollars). In an analysis, the appropriate inflation and discount factors would be applied to this salvage value to arrive at the proper discounted salvage value.

If the analyst is using ECONPACK, all calculations are made by the program. The program prompts for entry of the facility cost and land cost and allows the analyst either to use the OMB building obsolescence and site appreciation factors or enter some other schedules. An inflation schedule can also be selected to inflate both the building and land values.

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[6]OMB Circular A-104, *Evaluating Leases of Capital Assets* (OMB, 1 January 1986).

APPENDIX E:

FULLY DOCUMENTED ECONOMIC ANALYSIS EXAMPLE:
CONSOLIDATED WAREHOUSE COMPLEX

E X E C U T I V E S U M M A R Y R E P O R T

PROJECT TITLE: CONSOLIDATED WAREHOUSE COMPLEX
PROJECT OBJECTIVE: TO DETERMINE THE MOST COST EFFECTIVE ALTERNATIVE
DISCOUNT RATE: 9.13%
PERIOD OF ANALYSIS: 24 YEARS
START YEAR: 1989
BASE YEAR: 1989

ASSUMPTIONS OF THE ANALYSIS:

1. The period of analysis is 24 years.
2. Project economic life is 20 years.
3. The discount rate used was determined by selecting the interest rate of the treasury securities with maturity most nearly equal to the term of the lease and adding 1/8 of 1% to reflect the treasury charge for agency borrowing finance through the federal financing bank and equals 9.13%.
4. Personnel requirements for Status Quo and Upgrade alternatives will remain the same.
5. Equipment and furniture will be installed in the last year of construction.
6. Current method of operation will continue during construction.
7. Building construction will require 2 years for MCA and Third Party Financing. Construction will begin in 1991. Design year is 1990, and will be 6% of construction cost.
8. Salvage value for equipment which has not reached its economic life at the end of the analysis period is calculated using the Straight Line method of depreciation.
9. For upgrade, MCA, and Third Party Financing alternatives facility maintenance will be reduced 75% during construction. Utilities cost will increase by 25% during construction.
10. Funds will be available to implement all alternatives.
11. First year of operation for MCA and Third Party Financing alternatives is 1993.
12. Training costs will be incurred every time ADPE is replaced throughout the analysis.
13. All dollars are current, and all costs are assumed to be incurred at midyear.
14. Present equipment maintenance on Status Quo and Upgrade will be reduced by 30% due to equipment replacement.
15. Equipment requirements for Status Quo and Upgrade are estimated to be 25% of the equipment required for MCA and Third Party. Equipment will be installed starting on FY93 and replaced 16 years thereafter.

E X E C U T I V E S U M M A R Y R E P O R T

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:

Objective:

The objective of this study is to determine the most economic and efficient facility/facilities to accommodate the supply needs for the National Training Center (NTC).

Alternatives:

Five alternatives have been identified and four have been evaluated to solve the supply needs at Ft Irwin, CA. Leasing off post was not analyzed because the closest facilities are approximately 37 miles away, and leasing would be both uneconomical and geographically impractical.

1. Status Quo - Continue to operate in the existing facilities without Contractor continue to operate the function.

2. Upgrade - The government upgrades the existing facilities and the contractor continues to operate the function.

3. Military Construction Army (MCA) - The government designs, constructs, maintains the facility and the contractor continues to operate the function.

4. Third Party Financing (TPF) - A contractor designs, constructs, and maintains the facility and operates the function for 20 years.

Background.

Fort Irwin, CA, was reactivated in July 1981 as the National Training Center. Its major mission is to train mechanized infantry and armor battalions under simulated combat conditions over open terrain using modern test and evaluation equipment. Due to rapid growth, many installation facilities are inadequate relative to maintenance, supply, and logistic capabilities.

A study of the supply operations of the Directorate of Logistics (DOL) confirmed that supply operations utilized outdated equipment and facilities, with labor intensive manual processing. The warehousing activities, i.e., receiving, storage, shipping, inventory, picking, and requisitioning; are inadequate and unorganized. The majority of the warehouse buildings are wooden structures located throughout the cantonment

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS (cont.):

area, as much as six miles apart. These were constructed in 1942-43, and have design deficiencies which cannot be corrected by improved supply management and material handling methods. There is limited vertical space management because of: floor loading capabilities, ceiling heights, and location of structural columns. Other inadequacies are lack of humidity and temperature control for storage of perishables, pharmaceuticals, and other materials.

Logistics deficiencies occur because supplies are received and shipped from various locations and are stored in separate buildings in numerous rooms. Also material handling is accomplished by oversize forklifts and manual pallet jacks.

Inventory management from warehouse receipts to customer shipment is fundamentally a manual stock control card and key punch operation. The inventory levels are managed by updating the stock control cards through labor intensive (manual) keypunch procedures. Once the inventory management data is keyed into the Standard Army Intermediate Level Supply (SAILS) system, it is provided to management by batch-processing. The batch-processing procedure has significant shortcomings in providing up-to-date management information.

The proposed project will provide installation with an automated/consolidated warehouse facility to support the supply mission of the DOL. This project includes: site preparation and improvements, extension of existing utilities, storm drainage, telephone and automated data, processing communications, fire protection, installation of intrusion detection system, tie in to energy monitoring and control system, open storage, employee and customer parking, shipping and receiving operational parking and access drives, improvements to the entrance road, exterior lighting, and fencing. This facility will include space for general purpose warehouse, medical supply, shipping, receiving, supply services, and administration.

The new facility will consolidate most supply functions in one building to achieve economies of manpower and equipment. The special design of the facility will incorporate a 32 foot clear ceiling height. Administrative areas, complete with heating and air conditioning, will be constructed on the mezzanine level in a portion of the supply facility. Heating and air conditioning will be provided by a new self-contained plant.

Work methods and procedures will be studied to determine and implement the most effective and efficient organization. Additionally, a computer integrated logistics and flexible

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS (cont.):

material management system will be implemented. The flexibility, integration, and control resulting from the automated material

management system will provide the framework for the following expected benefits in real-time transaction visibility of the following functions: receiving, storage, shipping, intransit, inventory, picking, requisitions.

Material handling equipment and system development in the past few years have been highlighted by enhancements that not only improved control of physical material flow, but also managements' visibility of real-time information. Developments fall into one or more of the following areas:

a. Identification: bar code, RF, radio data terminals
b. Movement: conveyors, guided vehicles, lift trucks, robotics
c. Storage: AS/RS, mini-loads, carousel, tote stacker
d. Controls: sensors, computers, programmable controllers, packaged and custom software

Bar coding technology and mobile data terminals will be an integral part of the system. Each employee will have a bar coded identification badge that will replace the time card. The system will keep track of the time (s)he spends on each task. A set of standards can be incorporated into the system to provide comparisons between actual and standard times. It will be possible to generate efficiency measurements of individuals and groups.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC	SIR	DPP
1 STATUS QUO	$60,315,796	$6,278,025		
2 UPGRADE	$62,162,197	$6,470,210	0.77	
3 MCA	$57,474,535	$5,982,290	1.28	10.5 YEARS
4 THIRD PARTY	$56,845,928	$5,916,861	2.56	5.7 YEARS

RESULTS AND RECOMMENDATIONS:

1. Conclusions/Recommendations. The following is a ranking of the feasible alternatives:

Alternative	Net Present Value
Third Party	$56,845,928
MCA	$57,474,535
Status Quo	$60,315,796
Upgrade	$62,162,197

Based on the Net Present Value, Third Party Financing is the recommended action. This alternative will provide Fort Irwin, with and efficient, well organized installation supply function.

2. OPERATIONAL COST (OMA ANALYSIS):

Projected "OMA analysis" is based on FY88 figures. Analysis need to be validated/updated throughout project implementation. All figures have been taken from the preliminary economic analysis.

FORT IRWIN, CONSOLIDATED WAREHOUSE COMPLEX
DETAILED OPERATIONAL COST ELEMENT (OMA) ANALYSIS ($000)

COST	STATUS QUO		THIRD PARTY		MCA	
CATEGORY	1ST YEAR	2/20TH	1ST YEAR	2/20TH	1ST YEAR	2/20TH
Labor	$3,406	$3,406	$2,554	$2,554	$2,554	$2,554
Inventory	4,306	0	3,876	0	3,876	0
Pac maint	5.7	5.7	3.6	3.6	3.6	3.6
Equipment	97	97	90	90	90	90
Utilities	151	151	96	96	96	96
ADPE maint	0	0	120	120	120	120
Developer taxes	0	0	240	0	0	0
Real property taxes	0	0	110	110	0	0
Building lease	0	0	1,115	1,115	0	0
Insurance	0	0	107	107	0	0
TOTAL	$7,965.7	$3,659.7	$8,311.6	$4,195.6	$6,739.6	$2,863.6

RESULTS AND RECOMMENDATIONS (cont.):

FORT IRWIN, CONSOLIDATED WAREHOUSE COMPLEX
OPERATIONAL COST (OMA) SUMMARY ($M)
(FY93 THRU FY2012 ONLY)

	ANNUAL OPERATING BUDGET (FY88 BASELINE)	NET CHANGE FROM BASELINE LEVELS (SAVINGS)
FY88 BUDGET	$3.7	N/A
MCA	$2.9	-$0.8
THIRD PARTY	$4.2	$0.5

NOTE: As projected in preliminary economic analysis. Actual OMA outlays can vary based on numerous factors at time of operation/implementation.

3. THIS REPORT PREPARED BY:

HQ FORSCOM

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404-362-7513

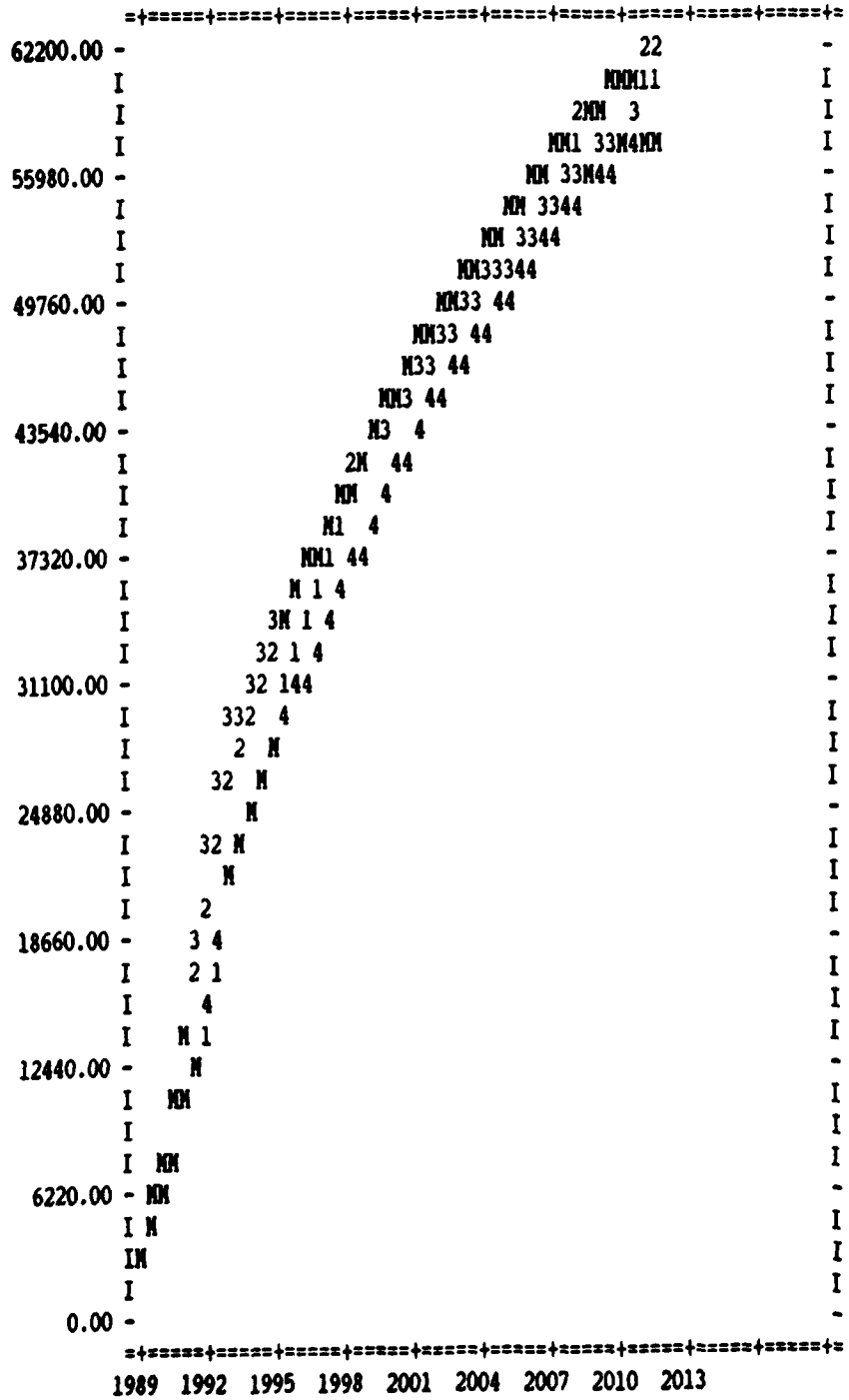
AV 797-7513

ACTION OFFICER: VICTOR BONILLA

ORGANIZATION : DOL

ECONOMIC ANALYSIS GRAPH 1

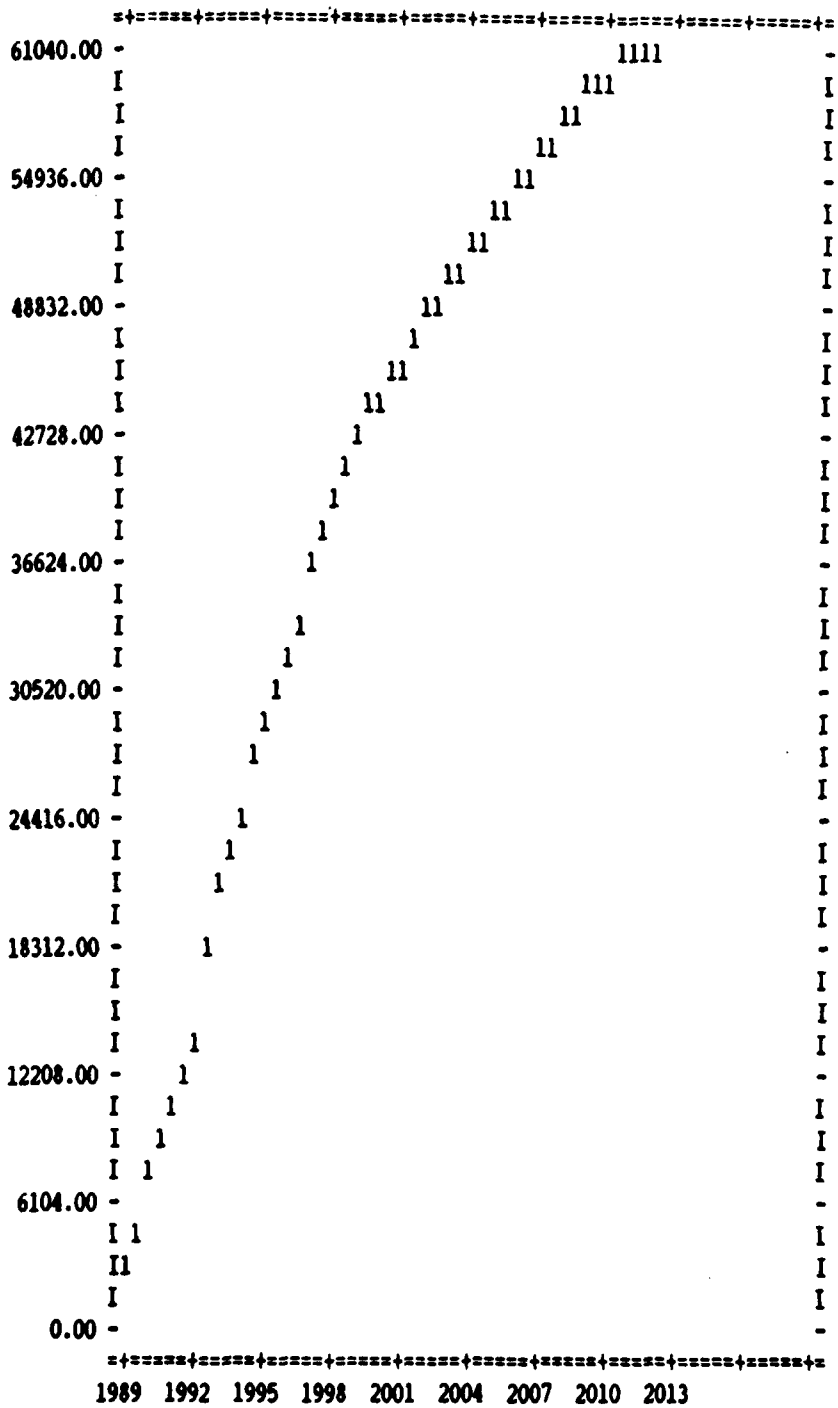
CUMULATIVE NET PRESENT VALUE ($ in thousands)



LEGEND	DESCRIPTION	LEGEND	DESCRIPTION
1	STATUS QUO	4	THIRD PARTY
2	UPGRADE	M	MERGING DATA
3	MCA		

ECONOMIC ANALYSIS GRAPH 2

CUMULATIVE NET PRESENT VALUE ($ in thousands)

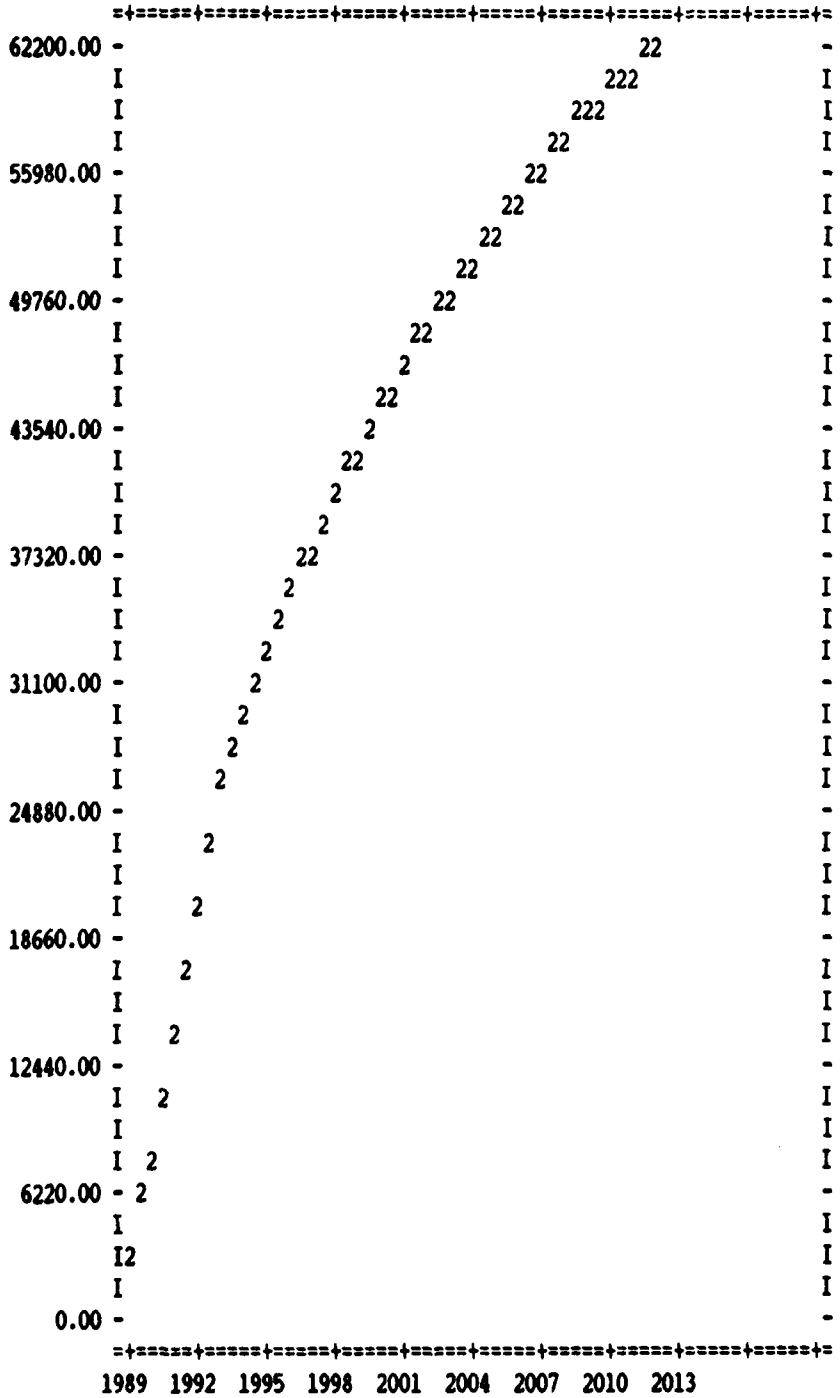


FISCAL YEAR

LEGEND	DESCRIPTION
1	STATUS QUO

ECONOMIC ANALYSIS GRAPH 3

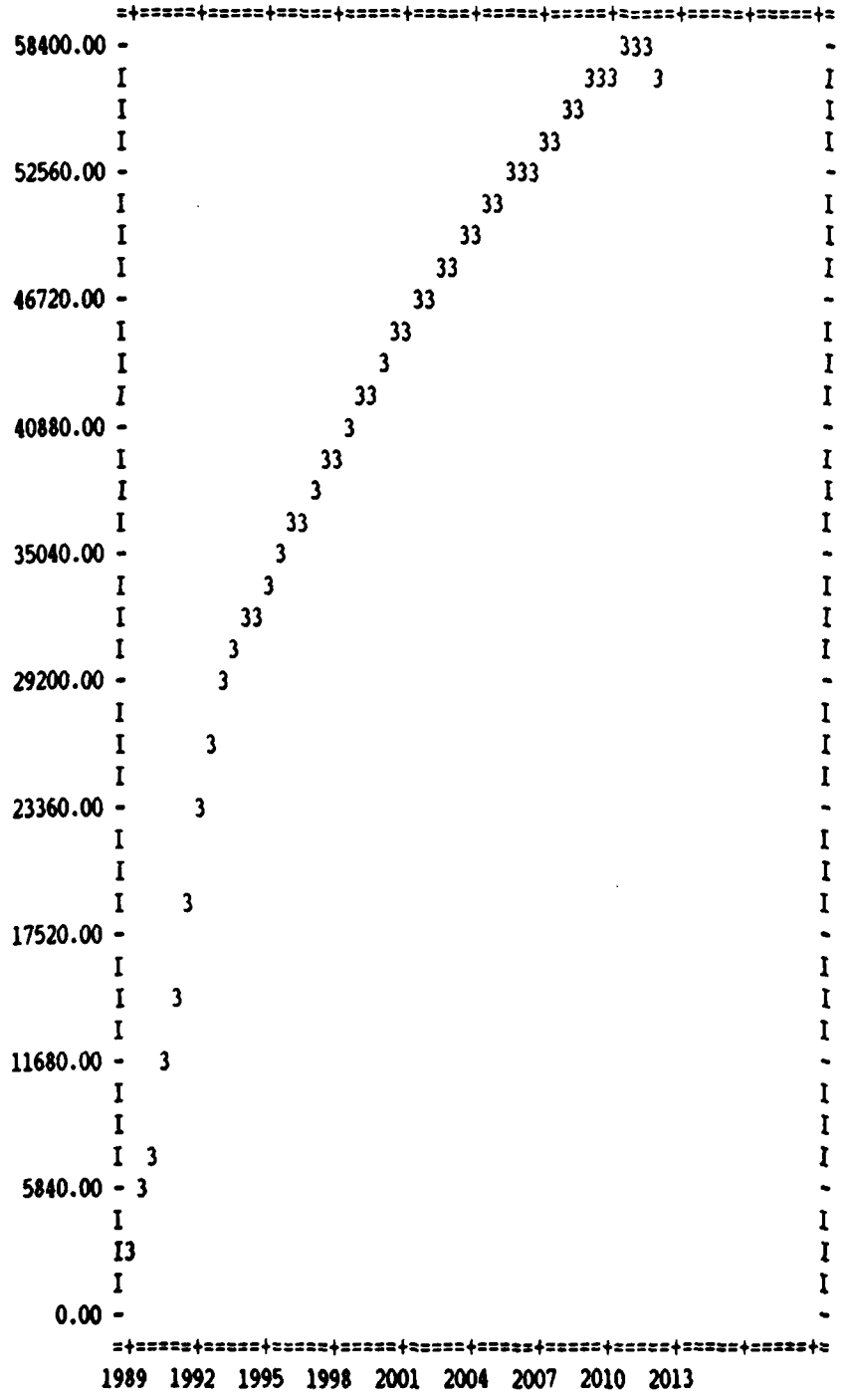
CUMULATIVE NET PRESENT VALUE ($ in thousands)



LEGEND	DESCRIPTION
2	UPGRADE

ECONOMIC ANALYSIS GRAPH 4

CUMULATIVE NET PRESENT VALUE ($ in thousands)



FISCAL YEAR

LEGEND	DESCRIPTION
3	MCA

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: STATUS QUO

YEAR	LABOR (01)	VALUE OF INVENTORY (02)	INVENTORY CARRYING COST (03)	FACILITY MAINTENANCE/REPAIR (04)	PRESENT EQUIPMENT MAINTENANCE (05)
1989	$3,439,843	$0	$0	$5,812	$141,616
1990	$3,525,797	$0	$0	$6,027	$146,856
1991	$3,631,571	$0	$0	$6,235	$151,922
1992	$3,740,518	$0	$0	$6,426	$156,556
1993	$3,852,734	$4,973,758	$0	$6,589	$112,383
1994	$3,968,316	$0	$508,815	$6,741	$114,968
1995	$4,087,365	$0	$520,518	$6,896	$117,612
1996	$4,209,986	$0	$532,490	$7,055	$120,317
1997	$4,336,286	$0	$544,737	$7,217	$123,085
1998	$4,466,374	$0	$557,266	$7,383	$125,916
1999	$4,600,365	$0	$570,083	$7,553	$128,812
2000	$4,738,376	$0	$583,195	$7,726	$131,774
2001	$4,880,528	$0	$596,609	$7,904	$134,805
2002	$5,026,943	$0	$610,331	$8,086	$137,906
2003	$5,177,752	$0	$624,368	$8,272	$141,077
2004	$5,333,084	$0	$638,729	$8,462	$144,322
2005	$5,493,077	$0	$653,420	$8,657	$147,642
2006	$5,657,869	$0	$668,448	$8,856	$151,037
2007	$5,827,605	$0	$683,823	$9,059	$154,511
2008	$6,002,433	$0	$699,551	$9,268	$158,065
2009	$6,182,506	$0	$715,640	$9,481	$161,700
2010	$6,367,982	$0	$732,100	$9,699	$165,420
2011	$6,559,021	$0	$748,938	$9,922	$169,224
2012	$6,755,792	$0	$766,164	$10,150	$173,116
%NPV	72.59	5.57	5.89	0.12	2.29

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: STATUS QUO

YEAR	MCA PROJECTS (06)	UTILITIES (07)	EQUIPMENT (08)	NEW EQUIPMENT MAINTENANCE (09)	EQUIPMENT SALVAGE (10)
1989	$0	$153,626	$0	$0	$0
1990	$0	$159,310	$0	$0	$0
1991	$0	$164,806	$0	$0	$0
1992	$1,225,000	$169,832	$0	$0	$0
1993	$1,225,000	$174,163	$433,131	$8,663	$0
1994	$1,300,000	$178,168	$0	$8,862	$0
1995	$1,300,000	$182,266	$0	$9,066	$0
1996	$2,250,000	$186,458	$0	$9,274	$0
1997	$2,250,000	$190,747	$0	$28,463	$0
1998	$2,325,000	$195,134	$0	$29,117	$0
1999	$2,325,000	$199,622	$0	$29,787	$0
2000	$0	$204,214	$0	$30,472	$0
2001	$0	$208,910	$0	$31,173	$0
2002	$0	$213,715	$0	$31,890	$0
2003	$0	$218,631	$0	$32,623	$0
2004	$0	$223,659	$0	$33,374	$0
2005	$0	$228,804	$0	$34,141	$0
2006	$0	$234,066	$0	$34,926	$0
2007	$0	$239,450	$0	$35,730	$0
2008	$0	$244,957	$609,192	$12,184	-$47,999
2009	$0	$250,591	$0	$12,464	$0
2010	$0	$256,354	$0	$12,751	$0
2011	$0	$262,251	$0	$13,044	$0
2012	$0	$268,282	$0	$40,032	-$293,247
%NPV	12.35	3.16	0.67	0.24	-0.08

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: STATUS QUO

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1989	$3,740,897	$3,580,996	$3,580,996	$0	$3,580,996
1990	$3,837,990	$3,366,570	$6,947,566	$0	$6,947,566
1991	$3,954,534	$3,178,594	$10,126,160	$0	$10,126,160
1992	$5,298,332	$3,902,426	$14,028,586	$0	$14,028,586
1993	$10,786,421	$7,279,954	$21,308,540	$0	$21,308,540
1994	$6,085,870	$3,763,829	$25,072,369	$0	$25,072,369
1995	$6,223,723	$3,527,064	$28,599,433	$0	$28,599,433
1996	$7,315,580	$3,798,984	$32,398,417	$0	$32,398,417
1997	$7,480,535	$3,559,649	$35,958,066	$0	$35,958,066
1998	$7,706,190	$3,360,240	$39,318,306	$0	$39,318,306
1999	$7,861,222	$3,141,061	$42,459,367	$0	$42,459,367
2000	$5,695,757	$2,085,421	$44,544,788	$0	$44,544,788
2001	$5,859,929	$1,966,032	$46,510,820	$0	$46,510,820
2002	$6,028,871	$1,853,488	$48,364,308	$0	$48,364,308
2003	$6,202,723	$1,747,400	$50,111,708	$0	$50,111,708
2004	$6,381,630	$1,647,392	$51,759,100	$0	$51,759,100
2005	$6,565,741	$1,553,121	$53,312,221	$0	$53,312,221
2006	$6,755,202	$1,464,252	$54,776,473	$0	$54,776,473
2007	$6,950,178	$1,380,477	$56,156,950	$0	$56,156,950
2008	$7,687,651	$1,399,210	$57,556,160	$0	$57,556,160
2009	$7,332,382	$1,222,897	$58,779,057	$0	$58,779,057
2010	$7,544,306	$1,152,976	$59,932,033	$0	$59,932,033
2011	$7,762,400	$1,087,058	$61,019,091	$0	$61,019,091
2012	$7,720,289	$990,709	$62,009,800	$1,694,004	$60,315,796
%NPV				-2.81	

EQUIVALENT UNIFORM ANNUAL COST = $6,278,025 (9.13% DISCOUNT RATE, 24 YEARS)

EXPENSE ITEMS 2, 3 AND 8 USED INFLATION INDEX 1 - ALL OTHER PROC.
EXPENSE ITEMS 4, 5, 7 AND 9 USED INFLATION INDEX 2 - O&M(EXCL FUEL).
EXPENSE ITEM 1 USED INFLATION INDEX 4 - CIVILIAN RAISES.

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: UPGRADE

YEAR	LABOR (01)	INVENTORY (02)	INVENTORY CARRYING COST (03)	FACILITY MAI NTENANCE AND REPAIR (04)	PRESENT EQUI PMENT MAINTE NANCE (05)
1989	$3,439,843	$0	$0	$5,812	$141,616
1990	$3,525,797	$0	$0	$6,027	$146,856
1991	$3,631,571	$0	$0	$1,559	$151,922
1992	$3,740,518	$0	$0	$1,606	$156,556
1993	$3,852,734	$4,973,758	$0	$6,589	$112,383
1994	$3,968,316	$0	$508,815	$6,741	$114,968
1995	$4,087,365	$0	$520,518	$6,896	$117,612
1996	$4,209,986	$0	$532,490	$7,055	$120,317
1997	$4,336,286	$0	$544,737	$7,217	$123,085
1998	$4,466,374	$0	$557,266	$7,383	$125,916
1999	$4,600,366	$0	$570,083	$7,553	$128,812
2000	$4,738,376	$0	$583,195	$7,726	$131,774
2001	$4,880,528	$0	$596,609	$7,904	$134,805
2002	$5,026,943	$0	$610,331	$8,086	$137,906
2003	$5,177,752	$0	$624,368	$8,272	$141,077
2004	$5,333,084	$0	$638,729	$8,462	$144,322
2005	$5,493,077	$0	$653,420	$8,657	$147,642
2006	$5,657,869	$0	$668,448	$8,856	$151,037
2007	$5,827,605	$0	$683,823	$9,059	$154,511
2008	$6,002,434	$0	$699,551	$9,268	$158,065
2009	$6,182,507	$0	$715,640	$9,481	$161,700
2010	$6,367,982	$0	$732,100	$9,699	$165,420
2011	$6,559,021	$0	$748,938	$9,922	$169,224
2012	$6,755,792	$0	$766,164	$10,150	$173,116
%NPV	70.44	5.40	5.72	0.10	2.22

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: UPGRADE

YEAR	UTILITIES (06)	FACILITY RENOVATION (07)	EQUIPMENT (08)	NEW EQUIPMENT MAINTENANCE (09)	EQUIPMENT SALVAGE (10)
1989	$153,616	$0	$0	$0	$0
1990	$159,300	$583,099	$0	$0	$0
1991	$206,008	$4,567,607	$0	$0	$0
1992	$212,291	$4,567,607	$0	$0	$0
1993	$174,151	$0	$433,131	$8,663	$0
1994	$178,157	$0	$0	$8,862	$0
1995	$182,254	$0	$0	$9,066	$0
1996	$186,446	$0	$0	$9,274	$0
1997	$190,734	$0	$0	$28,463	$0
1998	$195,121	$0	$0	$29,117	$0
1999	$199,609	$0	$0	$29,787	$0
2000	$204,200	$0	$0	$30,472	$0
2001	$208,897	$0	$0	$31,173	$0
2002	$213,701	$0	$0	$31,890	$0
2003	$218,616	$0	$0	$32,623	$0
2004	$223,645	$0	$0	$33,374	$0
2005	$228,788	$0	$0	$34,141	$0
2006	$234,051	$0	$0	$34,926	$0
2007	$239,434	$0	$0	$35,730	$0
2008	$244,941	$0	$609,192	$12,184	-$47,999
2009	$250,574	$0	$0	$12,464	$0
2010	$256,337	$0	$0	$12,751	$0
2011	$262,233	$0	$0	$13,044	$0
2012	$268,265	$0	$0	$40,032	-$293,247
%NPV	3.17	12.14	0.65	0.23	-0.07

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: UPGRADE

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1989	$3,740,887	$3,580,986	$3,580,986
1990	$4,421,079	$3,878,038	$7,459,024
1991	$8,558,667	$6,879,324	$14,338,348
1992	$8,678,578	$6,392,106	$20,730,454
1993	$9,561,409	$6,453,171	$27,183,625
1994	$4,785,859	$2,959,832	$30,143,457
1995	$4,923,711	$2,790,330	$32,933,787
1996	$5,065,568	$2,630,552	$35,564,339
1997	$5,230,522	$2,488,969	$38,053,308
1998	$5,381,177	$2,346,431	$40,399,739
1999	$5,536,210	$2,212,071	$42,611,810
2000	$5,695,743	$2,085,416	$44,697,226
2001	$5,859,916	$1,966,028	$46,663,254
2002	$6,028,857	$1,853,483	$48,516,737
2003	$6,202,708	$1,747,395	$50,264,132
2004	$6,381,616	$1,647,388	$51,911,520
2005	$6,565,725	$1,553,118	$53,464,638
2006	$6,755,187	$1,464,249	$54,928,887
2007	$6,950,162	$1,380,473	$56,309,360
2008	$7,687,636	$1,399,207	$57,708,567
2009	$7,332,366	$1,222,894	$58,931,461
2010	$7,544,289	$1,152,973	$60,084,434
2011	$7,762,382	$1,087,056	$61,171,490
2012	$7,720,272	$990,707	$62,162,197

EQUIVALENT UNIFORM ANNUAL COST = $6,470,210 (9.13% DISCOUNT RATE, 24 YEARS)

EXPENSE ITEMS 2, 3 AND 8 USED INFLATION INDEX 1 - ALL OTHER PROC.
EXPENSE ITEMS 4, 5, 6 AND 9 USED INFLATION INDEX 2 - O&M(EXCL FUEL).
EXPENSE ITEM 1 USED INFLATION INDEX 4 - CIVILIAN RAISES.

LIFE CYCLE COST REPORT

PRIMARY ECONOMIC ANALYSIS

PRESENT ALTERNATIVE: STATUS QUO
PROPOSED ALTERNATIVE: UPGRADE
ECONOMIC LIFE (PRESENT): 24 YEARS
ECONOMIC LIFE (PROPOSED): 24 YEARS

PROJECT YEAR(S)	RECURRING ANNUAL OPERATING COSTS PRESENT ALTERNATIVE	PROPOSED ALTERNATIVE	DIFFERENTIAL COST	PRESENT VALUE FACTOR	PRESENT VALUE OF DIFFERENTIAL COST
1989	$3,740,897	$3,740,887	$10	0.957	$10
1990	$3,837,990	$3,837,980	$10	0.877	$9
1991	$3,954,534	$3,991,060	-$36,526	0.804	-$29,358
1992	$4,073,332	$4,110,971	-$37,639	0.737	-$27,722
1993	$9,128,290	$9,128,278	$12	0.675	$8
1994	$4,785,870	$4,785,859	$11	0.618	$7
1995	$4,923,723	$4,923,711	$12	0.567	$7
1996	$5,065,580	$5,065,568	$12	0.519	$6
1997	$5,230,535	$5,230,522	$13	0.476	$6
1998	$5,381,190	$5,381,177	$13	0.436	$6
1999	$5,536,222	$5,536,210	$12	0.400	$4
2000	$5,695,757	$5,695,743	$14	0.366	$5
2001	$5,859,929	$5,859,916	$13	0.336	$4
2002	$6,028,871	$6,028,857	$14	0.307	$5
2003	$6,202,723	$6,202,708	$15	0.282	$5
2004	$6,381,630	$6,381,616	$14	0.258	$4
2005	$6,565,741	$6,565,725	$16	0.237	$3
2006	$6,755,202	$6,755,187	$15	0.217	$3
2007	$6,950,178	$6,950,162	$16	0.199	$4
2008	$7,126,458	$7,126,443	$15	0.182	$3
2009	$7,332,382	$7,332,366	$16	0.167	$3
2010	$7,544,306	$7,544,289	$17	0.153	$3
2011	$7,762,400	$7,762,382	$18	0.140	$2
2012	$8,013,536	$8,013,519	$17	0.128	$2
TOTALS	$143,877,276	$143,951,136	-$73,860		-$56,971

TOTAL PRESENT VALUE OF NEW INVESTMENT	$7,903,907
PLUS: PRESENT VALUE OF EXISTING ASSETS TO BE USED	$0
LESS: PRESENT VALUE OF EXISTING ASSETS REPLACED	$0
LESS: PRESENT VALUE OF TERMINAL VALUE OF ALTERNATIVE	$0
TOTAL PRESENT VALUE OF NET INVESTMENT	$7,903,907
TOTAL PRESENT VALUE OF DIFFERENTIAL COSTS	-$56,971
PLUS: PRESENT VALUE OF COST OF REFURBISHMENT OR MODIFICATION ELIMINATED	$7,808,481
LESS: STATUS QUO SALVAGE VALUE	$1,694,004
TOTAL PRESENT VALUE OF SAVINGS	$6,057,506
SAVINGS/INVESTMENT RATIO	0.77

SIR IS LESS THAN ONE AT END OF PERIOD OF ANALYSIS

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 3: MCA

YEAR	CONSTRUCTION (01)	LABOR (02)	INVENTORY (03)	INVENTORY CARRYING COST (04)	FACILITY MAINTENANCE AND REPAIR (05)
1989	$0	$3,439,843	$0	$0	$5,812
1990	$636,000	$3,525,797	$0	$0	$6,027
1991	$4,982,000	$3,631,571	$0	$0	$1,559
1992	$4,982,000	$3,740,518	$0	$0	$1,606
1993	$0	$2,889,550	$4,476,383	$0	$4,195
1994	$0	$2,976,237	$0	$457,934	$4,292
1995	$0	$3,065,524	$0	$468,467	$4,390
1996	$0	$3,157,489	$0	$479,241	$4,491
1997	$0	$3,252,214	$0	$490,264	$4,594
1998	$0	$3,349,781	$0	$501,540	$4,700
1999	$0	$3,450,274	$0	$513,075	$4,808
2000	$0	$3,553,782	$0	$524,876	$4,919
2001	$0	$3,660,396	$0	$536,948	$5,032
2002	$0	$3,770,207	$0	$549,298	$5,148
2003	$0	$3,883,314	$0	$561,932	$5,266
2004	$0	$3,999,813	$0	$574,856	$5,387
2005	$0	$4,119,808	$0	$588,078	$5,511
2006	$0	$4,243,402	$0	$601,604	$5,638
2007	$0	$4,370,704	$0	$615,441	$5,768
2008	$0	$4,501,825	$0	$629,596	$5,900
2009	$0	$4,636,880	$0	$644,077	$6,036
2010	$0	$4,775,986	$0	$658,890	$6,175
2011	$0	$4,919,266	$0	$674,045	$6,317
2012	$0	$5,066,844	$0	$689,548	$6,462
%NPV	14.32	62.38	5.26	5.57	0.08

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 3: MCA

YEAR	EQUIPMENT (06)	EQUIPMENT SALVAGE (07)	EQUIPMENT MAINTENANCE (08)	ADPE (09)	ADPE SALVAGE (10)
1989	$0	$0	$141,616	$0	$0
1990	$0	$0	$146,856	$0	$0
1991	$0	$0	$151,922	$0	$0
1992	$1,689,450	$0	$156,556	$1,351,560	$0
1993	$0	$0	$34,651	$0	$0
1994	$0	$0	$35,447	$0	$0
1995	$0	$0	$36,263	$0	$0
1996	$0	$0	$37,097	$0	$0
1997	$0	$0	$113,850	$0	$0
1998	$0	$0	$116,469	$0	$0
1999	$0	$0	$119,147	$0	$0
2000	$0	$0	$121,888	$1,625,171	$0
2001	$0	$0	$124,691	$0	$0
2002	$0	$0	$127,559	$0	$0
2003	$0	$0	$130,493	$0	$0
2004	$0	$0	$133,494	$0	$0
2005	$0	$0	$136,565	$0	$0
2006	$0	$0	$139,706	$0	$0
2007	$0	$0	$142,919	$0	$0
2008	$2,436,768	-$311,905	$48,735	$1,949,414	$0
2009	$0	$0	$49,856	$0	$0
2010	$0	$0	$51,003	$0	$0
2011	$0	$0	$52,176	$0	$0
2012	$0	-$2,087,004	$160,128	$0	-$1,334,401
%NPV	2.94	-0.56	1.88	3.38	-0.30

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 3: MCA

YEAR	ADPE MAINTENANCE (11)	TRAINING (12)	UTILITIES (13)	IMPUTED PROPERTY TAXES (14)	IMPUTED INSURANCE PREMIUMS (15)
1989	$0	$0	$153,626	$0	$0
1990	$0	$0	$159,310	$0	$0
1991	$0	$0	$206,008	$0	$0
1992	$0	$82,367	$212,291	$0	$0
1993	$138,602	$0	$110,882	$111,337	$109,154
1994	$141,790	$0	$113,432	$111,962	$109,767
1995	$145,051	$0	$116,041	$112,588	$110,381
1996	$148,387	$0	$118,710	$113,216	$110,996
1997	$151,800	$0	$121,440	$113,852	$111,620
1998	$155,292	$0	$124,233	$114,496	$112,251
1999	$158,863	$0	$127,091	$115,135	$112,878
2000	$162,517	$104,340	$130,014	$115,780	$113,510
2001	$166,255	$0	$133,004	$116,428	$114,145
2002	$170,079	$0	$136,063	$117,085	$114,789
2003	$173,991	$0	$139,193	$117,033	$114,738
2004	$177,992	$0	$142,394	$118,400	$116,079
2005	$182,086	$0	$145,669	$118,721	$116,393
2006	$186,274	$0	$149,019	$118,997	$116,664
2007	$190,559	$0	$152,447	$119,230	$116,892
2008	$194,941	$132,175	$155,953	$119,419	$117,077
2009	$199,425	$0	$159,540	$119,568	$117,223
2010	$204,012	$0	$163,209	$119,677	$117,331
2011	$208,704	$0	$166,963	$119,749	$117,401
2012	$213,504	$0	$170,803	$117,033	$117,433
%NPV	1.89	0.21	2.57	1.34	.31

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 3: MCA

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1989	$3,740,897	$3,580,996	$3,580,996	$0	$3,580,996
1990	$4,473,990	$3,924,450	$7,505,446	$0	$7,505,446
1991	$8,973,060	$7,212,406	$14,717,852	$0	$14,717,852
1992	$12,216,348	$8,997,811	$23,715,663	$0	$23,715,663
1993	$7,874,754	$5,314,815	$29,030,478	$0	$29,030,478
1994	$3,950,861	$2,443,423	$31,473,901	$0	$31,473,901
1995	$4,058,705	$2,300,119	$33,774,020	$0	$33,774,020
1996	$4,169,627	$2,165,289	$35,939,309	$0	$35,939,309
1997	$4,359,634	$2,074,555	$38,013,864	$0	$38,013,864
1998	$4,478,762	$1,952,936	$39,966,800	$0	$39,966,800
1999	$4,601,271	$1,838,502	$41,805,302	$0	$41,805,302
2000	$6,456,797	$2,364,064	$44,169,366	$0	$44,169,366
2001	$4,856,899	$1,629,508	$45,798,874	$0	$45,798,874
2002	$4,990,228	$1,534,173	$47,333,047	$0	$47,333,047
2003	$5,125,960	$1,444,060	$48,777,107	$0	$48,777,107
2004	$5,268,415	$1,360,021	$50,137,128	$0	$50,137,128
2005	$5,412,831	$1,280,400	$51,417,528	$0	$51,417,528
2006	$5,561,304	$1,205,463	$52,622,991	$0	$52,622,991
2007	$5,713,960	$1,134,935	$53,757,926	$0	$53,757,926
2008	$9,979,898	$1,816,417	$55,574,343	$0	$55,574,343
2009	$5,932,605	$989,441	$56,563,784	$0	$56,563,784
2010	$6,096,283	$931,679	$57,495,463	$0	$57,495,463
2011	$6,264,621	$877,307	$58,372,770	$0	$58,372,770
2012	$3,120,350	$400,420	$58,773,190	$1,298,655	$57,474,535

%NPV				-2.26	

EQUIVALENT UNIFORM ANNUAL COST = $5,982,290 (9.13% DISCOUNT RATE, 24 YEARS)

EXPENSE ITEMS 3, 4, 6, 7, 9 AND 10 USED INFLATION INDEX 1 - ALL OTHER PROC.
EXPENSE ITEMS 5, 8, 11 AND 13 USED INFLATION INDEX 2 - O&M(EXCL FUEL).
EXPENSE ITEMS 2 AND 12 USED INFLATION INDEX 4 - CIVILIAN RAISES.

L I F E C Y C L E C O S T R E P O R T

PRIMARY ECONOMIC ANALYSIS

PRESENT ALTERNATIVE: STATUS QUO
PROPOSED ALTERNATIVE: MCA
ECONOMIC LIFE (PRESENT): 24 YEARS
ECONOMIC LIFE (PROPOSED): 24 YEARS

	RECURRING ANNUAL OPERATING COSTS				
PROJECT YEAR(S)	PRESENT ALTERNATIVE	PROPOSED ALTERNATIVE	DIFFERENTIAL COST	PRESENT VALUE FACTOR	PRESENT VALUE OF DIFFERENTIAL COST
1989	$3,740,897	$3,740,897	$0	0.957	$0
1990	$3,837,990	$3,837,990	$0	0.877	$0
1991	$3,954,534	$3,991,060	-$36,526	0.804	-$29,358
1992	$4,073,332	$4,110,971	-$37,639	0.737	-$27,722
1993	$9,128,290	$7,874,754	$1,253,536	0.675	$846,036
1994	$4,785,870	$3,950,861	$835,009	0.618	$516,416
1995	$4,923,723	$4,058,705	$865,018	0.567	$490,218
1996	$5,065,580	$4,169,627	$895,953	0.519	$465,269
1997	$5,230,535	$4,359,634	$870,901	0.476	$414,420
1998	$5,381,190	$4,478,762	$902,428	0.436	$393,501
1999	$5,536,222	$4,601,271	$934,951	0.400	$373,573
2000	$5,695,757	$4,727,286	$968,471	0.366	$354,593
2001	$5,859,929	$4,856,899	$1,003,030	0.336	$336,524
2002	$6,028,871	$4,990,228	$1,038,643	0.307	$319,315
2003	$6,202,723	$5,125,960	$1,076,763	0.282	$303,340
2004	$6,381,630	$5,268,415	$1,113,215	0.258	$287,371
2005	$6,565,741	$5,412,831	$1,152,910	0.237	$272,721
2006	$6,755,202	$5,561,304	$1,193,898	0.217	$258,789
2007	$6,950,178	$5,713,960	$1,236,218	0.199	$245,542
2008	$7,126,458	$5,773,446	$1,353,012	0.182	$246,258
2009	$7,332,382	$5,932,605	$1,399,777	0.167	$233,456
2010	$7,544,306	$6,096,283	$1,448,023	0.153	$221,297
2011	$7,762,400	$6,264,621	$1,497,779	0.140	$209,751
2012	$8,013,536	$6,541,755	$1,471,781	0.128	$188,867
TOTALS	$143,877,276	$121,440,125	$22,437,151		$6,920,177

TOTAL PRESENT VALUE OF NEW INVESTMENT	$11,492,048
PLUS: PRESENT VALUE OF EXISTING ASSETS TO BE USED	$0
LESS: PRESENT VALUE OF EXISTING ASSETS REPLACED	$0
LESS: PRESENT VALUE OF TERMINAL VALUE OF ALTERNATIVE	$1,298,655
TOTAL PRESENT VALUE OF NET INVESTMENT	$10,193,393
TOTAL PRESENT VALUE OF DIFFERENTIAL COSTS	$6,920,177
PLUS: PRESENT VALUE OF COST OF REFURBISHMENT OR MODIFICATION ELIMINATED	$7,808,481
LESS: STATUS QUO SALVAGE VALUE	$1,694,004
TOTAL PRESENT VALUE OF SAVINGS	$13,034,654
SAVINGS/INVESTMENT RATIO	1.28
DISCOUNTED PAYBACK PERIOD	10.5 YEARS

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 4: THIRD PARTY

YEAR	LEASE (01)	UTILITIES (02)	FACILITY MAINTENANCE AND REPAIR (03)	LABOR (04)	INVENTORY (05)
1989	$0	$153,626	$5,812	$3,439,843	$0
1990	$0	$159,310	$6,027	$3,525,797	$0
1991	$0	$206,008	$1,559	$3,631,571	$0
1992	$0	$212,291	$1,606	$3,740,518	$0
1993	$1,115,192	$110,882	$4,195	$2,889,550	$4,476,383
1994	$1,115,192	$113,432	$4,292	$2,976,237	$0
1995	$1,115,192	$116,041	$4,390	$3,065,524	$0
1996	$1,115,192	$118,710	$4,491	$3,157,489	$0
1997	$1,115,192	$121,440	$4,594	$3,252,214	$0
1998	$1,115,192	$124,233	$4,700	$3,349,781	$0
1999	$1,115,192	$127,091	$4,808	$3,450,274	$0
2000	$1,115,192	$130,014	$4,919	$3,553,782	$0
2001	$1,115,192	$133,004	$5,032	$3,660,396	$0
2002	$1,115,192	$136,063	$5,148	$3,770,207	$0
2003	$1,115,192	$139,193	$5,266	$3,883,314	$0
2004	$1,115,192	$142,394	$5,387	$3,999,813	$0
2005	$1,115,192	$145,669	$5,511	$4,119,808	$0
2006	$1,115,192	$149,019	$5,638	$4,243,402	$0
2007	$1,115,192	$152,447	$5,768	$4,370,704	$0
2008	$1,115,192	$155,953	$5,900	$4,501,825	$0
2009	$1,115,192	$159,540	$6,036	$4,636,880	$0
2010	$1,115,192	$163,209	$6,175	$4,775,986	$0
2011	$1,115,192	$166,963	$6,317	$4,919,266	$0
2012	$1,115,192	$170,803	$6,462	$5,066,844	$0
%NPV	13.07	2.60	0.08	63.07	5.31

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 4: THIRD PARTY

YEAR	INVENTORY CARRYING COST (06)	EQUIPMENT (07)	EQUIPMENT SALVAGE (08)	EQUIPMENT MAINTENANCE (09)	ADPE (10)
1989	$0	$0	$0	$141,616	$0
1990	$0	$0	$0	$146,856	$0
1991	$0	$0	$0	$151,922	$0
1992	$0	$1,689,450	$0	$156,556	$1,351,560
1993	$0	$0	$0	$34,651	$0
1994	$457,934	$0	$0	$35,447	$0
1995	$468,467	$0	$0	$36,263	$0
1996	$479,241	$0	$0	$37,097	$0
1997	$490,264	$0	$0	$113,850	$0
1998	$501,540	$0	$0	$116,469	$0
1999	$513,075	$0	$0	$119,147	$0
2000	$524,876	$0	$0	$121,888	$1,625,171
2001	$536,948	$0	$0	$124,691	$0
2002	$549,298	$0	$0	$127,559	$0
2003	$561,932	$0	$0	$130,493	$0
2004	$574,856	$0	$0	$133,494	$0
2005	$588,078	$0	$0	$136,565	$0
2006	$601,604	$0	$0	$139,706	$0
2007	$615,441	$0	$0	$142,919	$0
2008	$629,596	$2,436,768	-$311,905	$48,735	$1,949,414
2009	$644,077	$0	$0	$49,856	$0
2010	$658,890	$0	$0	$51,003	$0
2011	$674,045	$0	$0	$52,176	$0
2012	$689,548	$0	-$2,087,004	$160,128	$0
%NPV	5.63	2.97	-0.57	1.90	3.42

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 4: THIRD PARTY

YEAR	ADPE SALVAGE (11)	ADPE MAINTENANCE (12)	TRAINING (13)	REAL PROPERTY TAXES (14)	INSURANCE (15)
1989	$0	$0	$0	$0	$0
1990	$0	$0	$0	$0	$0
1991	$0	$0	$0	$0	$0
1992	$0	$0	$82,367	$0	$0
1993	$0	$138,602	$0	$104,630	$102,579
1994	$0	$141,790	$0	$105,217	$103,154
1995	$0	$145,051	$0	$105,806	$103,731
1996	$0	$148,387	$0	$106,395	$104,309
1997	$0	$151,800	$0	$106,994	$104,896
1998	$0	$155,292	$0	$107,598	$105,489
1999	$0	$158,863	$0	$108,200	$106,078
2000	$0	$162,517	$104,340	$108,805	$106,672
2001	$0	$166,255	$0	$109,414	$107,269
2002	$0	$170,079	$0	$110,032	$107,874
2003	$0	$173,991	$0	$109,982	$107,826
2004	$0	$177,992	$0	$111,268	$109,086
2005	$0	$182,086	$0	$111,569	$109,382
2006	$0	$186,274	$0	$111,829	$109,636
2007	$0	$190,559	$0	$112,047	$109,850
2008	$0	$194,941	$132,175	$112,225	$110,024
2009	$0	$199,425	$0	$112,365	$110,162
2010	$0	$204,012	$0	$112,468	$110,262
2011	$0	$208,704	$0	$112,535	$110,329
2012	-$1,334,401	$213,504	$0	$112,566	$110,359
%NPV	-0.30	1.91	0.22	1.27	1.24

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 4: THIRD PARTY

YEAR	DEVELOPER TAXES (16)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL
1989	$0	$3,740,897	$3,580,996	$3,580,996	$0
1990	$0	$3,837,990	$3,366,570	$6,947,566	$0
1991	$0	$3,991,060	$3,207,952	$10,155,518	$0
1992	$0	$7,234,348	$5,328,376	$15,483,894	$0
1993	$277,204	$9,253,868	$6,245,605	$21,729,499	$0
1994	$0	$5,052,695	$3,124,857	$24,854,356	$0
1995	$0	$5,160,465	$2,924,502	$27,778,858	$0
1996	$0	$5,271,311	$2,737,395	$30,516,253	$0
1997	$0	$5,461,244	$2,598,762	$33,115,015	$0
1998	$0	$5,580,294	$2,433,253	$35,548,268	$0
1999	$0	$5,702,728	$2,278,605	$37,826,873	$0
2000	$0	$7,558,176	$2,767,318	$40,594,191	$0
2001	$0	$5,958,201	$1,999,000	$42,593,191	$0
2002	$0	$6,091,452	$1,872,729	$44,465,920	$0
2003	$0	$6,227,189	$1,754,293	$46,220,213	$0
2004	$0	$6,369,482	$1,644,256	$47,864,469	$0
2005	$0	$6,513,860	$1,540,848	$49,405,317	$0
2006	$0	$6,662,300	$1,444,114	$50,849,431	$0
2007	$0	$6,814,927	$1,353,614	$52,203,045	$0
2008	$0	$11,080,843	$2,016,797	$54,219,842	$0
2009	$0	$7,033,533	$1,173,054	$55,392,896	$0
2010	$0	$7,197,197	$1,099,929	$56,492,825	$0
2011	$0	$7,365,527	$1,031,480	$57,524,305	$0
2012	$0	$4,224,001	$542,046	$58,066,351	$1,220,423
%NPV	0.33				-2.15

LIFE CYCLE COST REPORT

PROJECT/PROGRAM COSTS

ALTERNATIVE 4: THIRD PARTY

YEAR	CUMULATIVE NET PRESENT VALUE
1989	$3,580,996
1990	$6,947,566
1991	$10,155,518
1992	$15,483,894
1993	$21,729,499
1994	$24,854,356
1995	$27,778,858
1996	$30,516,253
1997	$33,115,015
1998	$35,548,268
1999	$37,826,873
2000	$40,594,191
2001	$42,593,191
2002	$44,465,920
2003	$46,220,213
2004	$47,864,469
2005	$49,405,317
2006	$50,849,431
2007	$52,203,045
2008	$54,219,842
2009	$55,392,896
2010	$56,492,825
2011	$57,524,305
2012	$56,845,928

EQUIVALENT UNIFORM ANNUAL COST = $5,916,861 (9.13% DISCOUNT RATE, 24 YEARS)

EXPENSE ITEMS 5, 6, 7, 8, 10, 11 AND 16 USED
INFLATION INDEX 1 - ALL OTHER PROC.
EXPENSE ITEMS 2, 3, 9 AND 12 USED INFLATION INDEX 2 - O&M(EXCL FUEL).
EXPENSE ITEMS 4 AND 13 USED INFLATION INDEX 4 - CIVILIAN RAISES.

LIFE CYCLE COST REPORT

PRIMARY ECONOMIC ANALYSIS

PRESENT ALTERNATIVE: STATUS QUO
PROPOSED ALTERNATIVE: THIRD PARTY
ECONOMIC LIFE (PRESENT): 24 YEARS
ECONOMIC LIFE (PROPOSED): 24 YEARS

PROJECT YEAR(S)	RECURRING ANNUAL OPERATING COSTS PRESENT ALTERNATIVE	PROPOSED ALTERNATIVE	DIFFERENTIAL COST	PRESENT VALUE FACTOR	PRESENT VALUE OF DIFFERENTIAL COST
1989	$3,740,897	$3,740,897	$0	0.957	$0
1990	$3,837,990	$3,837,990	$0	0.877	$0
1991	$3,954,534	$3,991,060	-$36,526	0.804	-$29,358
1992	$4,073,332	$4,110,971	-$37,639	0.737	-$27,722
1993	$9,128,290	$8,976,664	$151,626	0.675	$102,336
1994	$4,785,870	$5,052,695	-$266,825	0.618	-$165,018
1995	$4,923,723	$5,160,465	-$236,742	0.567	-$134,165
1996	$5,065,580	$5,271,311	-$205,731	0.519	-$106,837
1997	$5,230,535	$5,461,244	-$230,709	0.476	-$109,787
1998	$5,381,190	$5,580,294	-$199,104	0.436	-$86,816
1999	$5,536,222	$5,702,728	-$166,506	0.400	-$66,530
2000	$5,695,757	$5,828,665	-$132,908	0.366	-$48,661
2001	$5,859,929	$5,958,201	-$98,272	0.336	-$32,968
2002	$6,028,871	$6,091,452	-$62,581	0.307	-$19,241
2003	$6,202,723	$6,227,189	-$24,466	0.282	-$6,893
2004	$6,381,630	$6,369,482	$12,148	0.258	$3,136
2005	$6,565,741	$6,513,860	$51,881	0.237	$12,273
2006	$6,755,202	$6,662,300	$92,902	0.217	$20,138
2007	$6,950,178	$6,814,927	$135,251	0.199	$26,863
2008	$7,126,458	$6,874,391	$252,067	0.182	$45,878
2009	$7,332,382	$7,033,533	$298,849	0.167	$49,843
2010	$7,544,306	$7,197,197	$347,109	0.153	$53,047
2011	$7,762,400	$7,365,527	$396,873	0.140	$55,578
2012	$8,013,536	$7,645,406	$368,130	0.128	$47,241
TOTALS	$143,877,276	$143,468,449	$408,827		-$417,663

TOTAL PRESENT VALUE OF NEW INVESTMENT	$3,447,369
PLUS: PRESENT VALUE OF EXISTING ASSETS TO BE USED	$0
LESS: PRESENT VALUE OF EXISTING ASSETS REPLACED	$0
LESS: PRESENT VALUE OF TERMINAL VALUE OF ALTERNATIVE	$1,220,423
TOTAL PRESENT VALUE OF NET INVESTMENT	$2,226,946
TOTAL PRESENT VALUE OF DIFFERENTIAL COSTS	-$417,663
PLUS: PRESENT VALUE OF COST OF REFURBISHMENT OR MODIFICATION ELIMINATED	$7,808,481
LESS: STATUS QUO SALVAGE VALUE	$1,694,004
TOTAL PRESENT VALUE OF SAVINGS	$5,696,814
SAVINGS/INVESTMENT RATIO	2.56
DISCOUNTED PAYBACK PERIOD	5.7 YEARS

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

Major Cost Elements Build-Up:

This section describes the procedures followed in the derivation of cost items included in this economic analysis. The resulting figures were used in calculating present value cost estimates for the various alternatives. Inflation indexes were taken from PBC-Memo 88-57 dated 1 Feb 88.

1. Construction. Facility renovation costs were based on current average costs at Ft Irwin for complete renovation of maintenance facilities. Based upon historical rates established for Fort Irwin, it is estimated these costs will be approximately $38.67 per square foot and include major upgrading of structures, wiring, and communications requirements. MCA construction is based on historical construction rates from AR 415-17 escalated to FY91 dollars. The Third Party construction costs are based on experience of private industry with maintenance facility construction. Cost estimates were obtained from Means and discussions with contractors contacted through the Thomas Register. Building salvage was taken from OMB Circular A-104 and based on a 20 year economic life.

2. Equipment. Equipment requirements identified for the MCA and Third Party Financing alternatives was based on a review of present equipment. Cost reflects state-of-the-art equipment identified to maximize productivity in maintenance operations. Purchase and maintenance estimates were provided by contractors contacted through the Thomas Register. The economic life for equipment is estimated to be 16 years. Maintenance for equipment was estimated to be 2% of the acquisition cost for the first year and 6% per year thereafter. Residual value calculations are based on Part 4, appendix C, of OMB Circular A-76 and are figured at 12.8%.

3. Control Systems. Acquisition and maintenance costs associated for the MCA and Third Party Financing alternatives equate to private industry estimates (through the Thomas Register) of the state-of-the-art automation available. If the Third Party Financing alternative is implemented automation would provide DOL the ability to streamline their operation, reduce personnel, and increase productivity. The economic life for ADPE is 8 years with no residual value for ADPE which has reached the end of its economic life (Part 4, appendix C, of OMB Circular A-76). Salvage value for ADPE which has not reached the end of its economic life was calculated using straight-line

SOURCE AND DERIVATION OF COSTS AND BENEFITS (cont.):

depreciation. ADPE maintenance per year is estimated to be 10% of acquisition cost.

4. Personnel. Status Quo salaries were estimated by using fully burdened FY8? actual salary costs gotten from the Installation Directorate of Resource Management. The projected savings in manpower, if the Third Party alternative is implemented will be approximately 25% per year. This estimated reduction in labor costs is justified by the use of state-of-the-art equipment, a condensed logistics system, shorter supply lines, better layout, and improved methods.

5. Utilities. Utility cost elements are based on the Facility Engineering and Housing Annual Summary of Operations (The Red Book).

6. Taxes. State of California tax rates were obtained from the local assessor and consist of:

a. Developer tax, which is a one-time $1.50/s.f. charge.
b. Property tax, consisting of 1% of the facility's value with a 2% inflation index to span the 20 year life of the project.

7. Residual values. Equipment and building residual values are treated as negative expense items.

8. Inventory. The value of the combined inventory is approximately $4,306,221. Through consolidation of these functions, implementation of high rise storage and real time inventory control, current inventory levels can be reduced 10% according to the experience of private industry personnel contacted.

9. Lease. The facility lease for the Third Party alternative was calculated based on a loan of $10,435,251 at 10% for a 20 year period. Lease cost does not include profit. Facility cost was estimated by installation DEH using Means.

Benefits:

In addition to the economic factors that made this project attractive, the following nonquantifiable benefits are also recognized, if the Third Party Financing alternative is implemented.

1. Increased readiness.
2. Improved customer support capability by consolidating facilities.
3. Increased morale and quality control.
4. Proper layout.
5. Reduced inventory time, increased inventory accuracy.

6. A facility which can be easily converted from a peacetime mission to a wartime mission.
7. Improved productivity, safety, and morale of work force

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... BUILDING LEASE

ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 3 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
3	** NOTHING CHANGED **
4	1

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
3	$57,474,535

FOR ALTERNATIVE 3 TO BE LEAST COST, INCREASE COSTS BY 8.46% OR MORE.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 02
TITLE ..... MANPOWER

ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 3 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
3	** NOTHING CHANGED **
4	4

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
3	$57,474,535

FOR ALTERNATIVE 3 TO BE LEAST COST, INCREASE COSTS BY 1.75% OR MORE.

RANKING SENSITIVITY ANALYSIS

SENSITIVITY ANALYSIS NUMBER 03
TITLE ..... EQUIP/EQUIP MAINT/ADPE/ADPE MAINT
ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 3 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
3	** NOTHING CHANGED **
4	7 8 9 10 11 12

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
3	$57,474,535

FOR ALTERNATIVE 3 TO BE LEAST COST, INCREASE COSTS BY 11.86% OR MORE.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 04
TITLE ..... LEASE

ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 1 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	** NOTHING CHANGED **
4	1

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
1	$60,315,796

FOR ALTERNATIVE 1 TO BE LEAST COST, INCREASE COSTS BY 46.71% OR MORE.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 05
TITLE ..... MANPOWER

ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 1 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	** NOTHING CHANGED **
4	4

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
1	$60,315,796

FOR ALTERNATIVE 1 TO BE LEAST COST, INCREASE COSTS BY 9.68% OR MORE.

RANKING SENSITIVITY ANALYSIS

SENSITIVITY ANALYSIS NUMBER 06
TITLE ..... EQUIP/EQUIP MAINT/ADPE/ADPE MAINT
ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 1 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	13
4	7 8 9 10 11 12 13

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
1	$60,315,796

FOR ALTERNATIVE 1 TO BE LEAST COST, INCREASE COSTS BY 63.96% OR MORE.

RANKING SENSITIVITY ANALYSIS

SENSITIVITY ANALYSIS NUMBER 07
TITLE ..... INVENTORY

ALLOWABLE CHANGE ..... 200.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 1 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	** NOTHING CHANGED **
4	5 6

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 200.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
4	$56,845,928
1	$60,315,796

FOR ALTERNATIVE 1 TO BE LEAST COST, INCREASE COSTS BY 55.78% OR MORE.

APPENDIX F:

FACILITY AGE ESCALATION FACTORS FOR MAINTENANCE COSTS

The annual maintenance cost can be adjusted to reflect the age of a facility. Maintenance costs can be escalated over the life of a facility to reflect increasing maintenance requirements as the facility ages. Table F provides building age multipliers that can be used to escalate maintenance costs. Note that if a facility is not new, a building age multiplier would be used starting in the first year of the analysis. For example, if a warehouse in Louisiana is 15 years old at the time of the analysis, the annual maintenance would be multiplied by 1.40 (the age multiplier for buildings from 10 to 19 years old) in the first year. In the sixth year of the analysis the warehouse would be 20 years old, so the age multiplier would be changed to 1.90 (building 20 to 29 years old). It would remain there until the 16th year, when it would be increased to 2.10, and so on.

Table F

Building Age Multipliers

Years	Multipliers
0 - 9	1.00
10 - 19	1.40
20 - 29	1.90
30 - 39	2.10
40 - 49	2.10
50 Plus	1.65

Source: *Military Construction Program Economic Analysis Manual*, prepared for The United States Air Force by Oak Ridge National Laboratory, Oak Ridge, TN 37831.

ACRONYMS

AIA:	American Institute of Architects
ADPE:	automatic data processing equipment
AMS:	Army management structure
AR:	Army Regulation
BAQ:	basic allowance for quarters
BOMA:	Building Owners and Managers Association
BOD:	beneficial occupancy date
BMAR:	backlog of maintenance and repair
BY	budget year
CFF:	commercially financed facilities
Circ:	Circular
COMSEC:	communications and security (equipment)
CPO:	Civilian Personnel Office
CRF:	capital recovery act
CRRC	Construction Requirements Review Committee
C/S	Chief of Staff, Army
DD:	Defense Department
DEH:	Directorate of Engineering and Housing
DOC:	Directorate of Contracting
DOD:	Department of Defense
DOIM:	Directorate of Information Management
DOL:	Directorate of Logistics
DRM:	Directorate of Resource Management
DU:	dwelling unit
DY	design year
E/A	economic analysis
EIRS:	engineering improvement recommendation system
ECONPACK:	Economic Analysis Package
EP&S:	Engineer Plans and Services (Division)
ERMD:	Engineer Resource Management Division
ETL:	Engineer Technical Letter
EUAC:	equivalent uniform annual cost
FORSCOM:	U.S. Army Forces Command
FY:	fiscal year
FYP:	five year program
GSA:	General Services Administration
GY:	guidance year
HVAC:	heating, ventilating, and air conditioning
IFS:	integrated facilities system
ISC:	U.S. Army Information Systems Command
JTR:	joint travel regulation
LRCP:	Long-Range Construction Program
MCA:	Military Construction, Army
MPL:	Mobilization Project List
M&R:	maintenance and repair
NBS:	National Bureau of Standards
NIST:	National Institute of Standards and Technology
NPV:	net present value
NSA:	National Security Agency
OCE:	Office of the Chief of Engineers
O&M:	operations and maintenance
OMB:	Office of Management and Budget
OSD:	Office of the Secretary of Defense
PAX:	Programming, Administration, and Execution (System)
PBC:	Program and Budget Committee

PBG:	Program and Budget Guidance
PC:	personal computer
PM:	preventive maintenance
PN:	personnel
POM:	Program Objective Memorandum
PY:	program year
RR:	railroad
SA:	Secretary of the Army
SF:	square feet
SIDPERS:	Standard Installation/Division Personnel System
SR:	separate rations
SRP:	Special Requirements Paragraph
TAG:	The Adjutant General
TMP:	transportation motor pool
TOE:	tables of organization and equipment
TRADOC:	U.S. Army Training and Doctrine Command
UPH:	unaccompanied personnel housing
USACERL:	U.S. Army Construction Engineering Research Laboratory
VHA:	variable housing allowance

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